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Proceedings of the Symposium To Review Volume III of the 1978 Annual Report to Congress

November 7-8, 1979

MASTER

Prepared for
U.S. Department of Energy
Energy Information Administration
Assistant Administrator for Applied Analysis
Under Grant No. DE-FG01-79EI10587

DISCLAIMER

DISCLAIMER

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Proceedings of the Symposium To Review Volume III of the 1978 Annual Report to Congress

November 7-8, 1979

Symposium Coordinators

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Prepared for
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Assistant Administrator for Applied Analysis
Office of Analysis Oversight and Access
Washington, DC 20461
Under Grant No. DE-FG01-79-EI10587

Contractor Report

ABSTRACT

This contractor report is a transcript of the proceedings of a two-day Symposium, held at the University of Maryland. The Symposium was held in the Fall of 1979 to independently review the Energy Information Administration (EIA) Annual Report to Congress (ARC), Volume Three. The ARC was delivered to the Congress and the public in July 1979. Participants included energy forecasting experts from the academic community and the private sector; other Federal, State, and local government energy experts; and Office of Applied Analysis, EIA staff members. The Symposium and its Transcript cover the underlying 1978 ARC assumptions, methodologies, and energy system projections. Discussions cover the short-, mid and long-term periods, national and international forecasts, source and consuming sectors and projected economic impacts.

FOREWARD

The Federal Energy Administration Act of 1974, as amended by the Energy Conservation and Production Act of 1975 and the Department of Energy Organization Act of 1976, specify that the Administrator of the Energy Information Administration (EIA) provide Congress with an annual report. The current report is titled the Annual Report to Congress: 1978. It describes, in part, short-, mid, and long-term energy consumption and supply trends and forecasts under various assumptions. Because of the crucial role these forecasts play in helping formulate U.S. Government energy policies, EIA considers it an important goal to transmit to the general community greater information on its activities and for the community to constructively respond to these activities to assure sound forecasts and resultant energy policy decisions for the future.

To meet this goal a symposium was conducted reviewing EIA's Annual Report to Congress: 1978, Volume III. The Symposium consisted of a series of sessions where DOE and non-DOE energy/forecasting experts reviewed EIA's assumptions and methodologies with regard to forecasts by time (short-, mid, and long-term), by source (oil, natural gas, coal, nuclear, and electricity), by use (residential, commercial, and industrial), and by impact (economic and environmental). This report contains the Proceedings of the Symposium to Review the 1978 Annual Report to Congress, Volume III. It is hoped that these Proceedings prove of value in helping EIA prepare future reports and interested parties, both government and non-government, in their use. This report is organized with the transcripts of the sessions as conducted at the Symposium presented first, followed by summary and conclusions.

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Symposium to Review

EIA's 1978 Annual Report to Congress, Volume III

November 7-8, 1979
College Park, Maryland

Sponsored by

Energy Information Administration
U.S. Department of Energy

Conducted by

College of Business and Management
University of Maryland at College Park

In cooperation with
Conferences and Institutes Division
University of Maryland University College

PROGRAM

Wednesday, 7 November

7:00-8:45 a.m.	REGISTRATION AND COFFEE
8:45-9:00 a.m.	WELCOME Douglas Norland, University of Maryland, College Park, Maryland Francis Alt, University of Maryland, College Park, Maryland Dean Rudolph P. Lamone, College of Business and Management, University of Maryland, College Park, Maryland
9:00-10:30 a.m.	ANALYTIC OBJECTIVES AND STUDY DESIGN George Lady, Energy Information Administration, Washington, D.C. W. Charles Mylander, Energy Information Administration, Washington, D.C.
10:30-10:45 a.m.	COFFEE
10:45-10:50 a.m.	SHORT-TERM ENERGY SUPPLY AND DEMAND R. Gene Clark, Energy Information Administration, Washington, D.C.

10:50-12:00 noon	MIDTERM ENERGY SUPPLY AND DEMAND W. Charles Mylander, Energy Information Administration, Washington, D.C. T. Takayama, Energy Information Administration, Washington, D.C. Terry H. Morlan, Energy Information Administration, Washington, D.C.
12:00-1:00 p.m.	LUNCH
1:00-3:00 p.m.	MIDTERM--Cont'd. Clopper Almond, Jr., University of Maryland, College Park, Maryland E. A. Hudson, Dale Jorgenson Associates, Cambridge, Massachusetts James J. MacKenzie, Council on Environmental Quality, Washington, D.C.
3:00-3:15 p.m.	COFFEE
3:15-5:00 p.m.	LONG-TERM ENERGY SUPPLY AND DEMAND John D. Pearson, Energy Information Administration, Washington, D.C. Kenneth Hoffman, Math-tech, Inc., Arlington, Virginia David Knapp, Chase Manhattan Bank, New York, New York Russell Thompson, Research for Growth and Transfer, Inc., Houston, Texas
5:00 p.m.	ADJOURNMENT

Thursday, 8 November

9:00-10:30 a.m.	ENERGY SOURCES (Concurrent Sessions) OIL AND NATURAL GAS Charles G. Everett, Energy Information Administration, Washington, D.C. Richard O'Neill, Energy Information Administration, Washington, D.C. Edward W. Erickson, North Carolina State University, Raleigh, North Carolina Milton Holloway, Texas Energy & Natural Resource Advisory Council, Austin, Texas Edward Murphy, American Petroleum Institute, Washington, D.C.

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10:30-10:45 a.m. COFFEE

10:45-12:00 noon ENERGY SOURCES (Concurrent Sessions)--Cont'd.

OIL AND NATURAL GAS

Benjamin Schlesinger, American Gas Association, Arlington, Virginia
William Vogely, Pennsylvania State University, University Park, Pennsylvania

ELECTRICITY

Betsy O'Brien, Energy Information Administration, Washington, D.C.
Jerry M. Eyster, Energy Information Administration, Washington, D.C.
R. Gene Clark, Energy Information Administration, Washington, D.C.
Martin Baughman, University of Texas at Austin, Austin, Texas
Jerry Karaganis, Edison Electric Institute, Washington, D.C.

12:00-1:00 p.m. LUNCH

1:00-3:15 p.m. ENERGY USES

Thomas J. Mooney, Energy Information Administration, Washington, D.C.
C. Patrick Bell, Pace Companies, Houston, Texas
John Castellani, National Association of Manufacturers, Washington, D.C.
Ronald Eash, Chicago Area Transportation Study, Chicago, Illinois
R. B. Guerin, Shell Oil Company, Houston, Texas

3:15–3:30 p.m.	COFFEE
3:30–5:00 p.m.	ENERGY IMPACTS A. David Sandoval, Energy Information Administration, Washington, D.C. Bill Curtis, Energy Information Administration, Washington, D.C. Edward Pechan, Energy Information Administration, Washington, D.C. Edward Bentz, Jr., National Alcohol Fuels Commission, Washington, D.C. Larry Moss, Energy Consultant, Falls Church, Virginia Edwin Rothschild, Energy Action Education Foundation, Washington, D.C.
5:00 p.m.	ADJOURNMENT

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ACKNOWLEDGMENT

The coordinators of the Symposium would like to express their appreciation to those who spoke at the Symposium and especially to those who edited their remarks for inclusion in this volume. The Symposium would not have been a success without the efforts of those who participated in the panel discussions, those who helped us contact prospective speakers and participants, those who helped design the Symposium format, and, finally, those who attended the Symposium.

Special thanks go to Richard O'Neill and William Weinig, both from the Energy Information Administration, for their guidance in the initial and final planning stages. Special thanks go also to Diane Kretschmer of the College of Business and Management and Jim Zigler of the Conference and Institutes Division of the University of Maryland for their hard work in making all Symposium arrangements run smoothly. Finally, thanks go to Aileen Arnold, Janice Klarman, Jane Davis, Peggy Beland, and Susie Allman for the typing of this manuscript.

Note: Several panelists, as indicated in the Proceedings, contributed papers in addition to their remarks at the Symposium. These were greatly appreciated but were not included in the Proceedings because such papers were not required of any speaker. We suggest interested readers contact directly those speakers for their papers.

Also, copies of slides used in most presentations were re-typed; however, most figures were included as received.

P R O C E E D I N G S

CHAPTER 1

WELCOME

SPEAKERS:

Dr. Douglas Norland, University of Maryland
Dr. Francis Alt, University of Maryland
Dean Rudolph P. Lamone, University of Maryland
Dr. George Lady, Energy Information Administration

DR. NORLAND: I am Douglas Norland, one of your co-coordinators for this Symposium to Review the Energy Information Administration's 1978 Annual Report to Congress, Volume III.

The symposium is sponsored by the College of Business and Management at the University of Maryland, in cooperation with the Conferences and Institutes Division of the University of Maryland University College, under a grant from the Energy Information Administration.

Before I introduce our other co-coordinator, I would like to express thanks and appreciation to several people for their hard work and cooperation in helping toward putting this symposium together.

First, from the Energy Information Administration, I would like to express thanks to Mr. William Weinig and Dr. Richard O'Neill for their help in the initial and final planning of the symposium; from the College of Business and Management, I would like to thank Diane Kretschmer, who was very helpful in coordinating and making symposium arrangements, here, along with Jim Zigler at the Conference and Institutes Division.

Also, special thanks, for his effort and hard work, go to my co-coordinator, Dr. Frank Alt, Professor of Statistics in the University of Maryland College of Business and Management.

Frank will make some brief remarks regarding housekeeping details and will make the next introduction.

DR. ALT: Thank you. To echo Doug's remarks, I also welcome you, and I hope you enjoy your stay at the symposium. As with any symposium, there will be certain things that will be appealing to you and some that will not be so appealing; where we have the good and the bad.

Whenever I hear that, I think of the family that had two children. One child was very optimistic, and one was very pessimistic. So, on a gift-giving occasion, the family thought they would reverse the roles of these two children.

So, they led the child who was pessimistic into a room that was laden with very nice toys. Much to their amazement, the child started crying and would not stop.

They said, "Why are you crying? We thought you would be happy."

He said, "Well, if I play with the drum, the canvas will break. If I play with the gun, it will fall apart. If I play with the train, it will fall off the tracks." The child just continued crying.

Well, they took the child who was very optimistic, and said, "We are bound to enjoy more success in this case." They led him into a room. There is no other way to describe it. There was nothing in there but a big pile of horse manure.

Again, much to their amazement, the child's eyes lit up.

They said, "Wait, we thought you would be completely unhappy with this."

He said, "No way. Any room that has this much horse manure in it, there is bound to be a pony underneath."

(Laughter.)

So, I hope that you will think we are always leading you into the right room, and you will always find the pony; regardless of how you initially think it may start out.

(Laughter.)

But, I would like to address a few issues regarding, as Doug said, the housekeeping issues. We will try to start the sessions on time;

however, there will probably be some flexibility.

The room designations are on the agenda that you were given when you registered. Those who wish to have messages left for them, the front desk number is: 779-5100. If the message is not an emergency, it will be placed on the bulletin board in the concourse registration area. If it is an emergency, then you may have the calling party page you.

As you were also, hopefully, told, lunch will be in the Chesapeake Room, which is in the concourse registration area. The coffee break will also be held in the concourse registration area.

For those staying overnight, there is restaurant information by the front desk. Those of you who are visitors and not familiar with this area, there are many very fine restaurants in the Washington, D.C. and Metropolitan D.C. area. I think that just about takes care of all the housekeeping issues.

Again, I would like to thank my co-coordinator, Professor Douglas Norland, who did most of the details and had this set up quite nicely when I joined the venture. Now, it's my pleasure to introduce my boss, who is Dean Lamone, Dean of the College of Business and Management at the University of Maryland.

DEAN LAMONE: Thank you very much, Frank. It is both a personal and professional honor to welcome you to the University of Maryland. We are delighted to serve as the host institution and to play a role in the development of this important and, in some sense I believe, innovative kind of conference.

A conference which brings together a group of knowledgeable and distinguished individuals representing various points of view to share ideas on a major public policy issue, and to review, as in our case, the Energy Information Administration's 1978 Annual Report to Congress. Now, while I believe the executive agencies have been encouraged in the past, by a number of people, to submit their proposed plans to formal public critiques, I believe that the EIA is among the first to do so. I congratulate them on taking this initiative.

I'm sure you will have an excellent conference. Thank you very much.

DR. ALT: It is now my pleasure to introduce the EIA representative who is Dr. George Lady, whose title is Director of Analysis Oversight and Access.

DR. LADY: A fair portion of the chain of command has to be missing for me to be the EIA representative. We had hoped that Roger Glassey, who is the Assistant Administrator for Applied Analysis, could be here, but he could not. He was away for two weeks. We, therefore, hoped that his deputy, Ken Kincel, could be here. He, at the last minute, could not. Since I was going to be here anyway, here I am. I welcome you for them.

I hope that this symposium, the first for us, does work out. I am essentially sitting on a bridge. In a certain sense, I'm overhead. I'm not a resource to you in a careful consideration of the report, but I do want to talk a little about what was in our mind when we called a conference.

That is worth talking about, perhaps, but I will be very brief, because the interesting material comes next. Anyway, it is good luck to have been with the Department of Energy and predecessor organizations, so that I have been associated with, but by no means, a major contributor to a continuum of analysis that began back in 1974 and resulted in a report about Project Independence. In fact, from the standpoint of those individuals, many of whom are still with the department in the analysis group, the annual report that we just released is just one of a sequence of reports. It's just been the most recent one as a result.

Since it's appropriate to have a joke of some kind, I want to tell you the joke that was told at the meeting after the first of these reports was published, which was in November of 1974. The people responsible for that report had worked very hard, as did the people responsible for this report. The joke that was told by the leader of that group is appropriate, now, and is really indicative of what the purpose of this is. So, here is the joke.

The joke has to do with a hippopotamus who came to the wise old owl for advice. The hippopotamus said that he had just fallen in love with a canary. It was just hopeless. His days were consumed with the situation; and he was a little up against it. He didn't know what to do.

So, the wise old owl said, "The only thing to do in a situation like this is to go back to the canary, express his feelings, and consummate the relationship."

So, the hippopotamus said, "Thank you, very much," and left. Some days passed.

Pretty soon, the hippopotamus showed up again and said, well, that he had taken his advice, carefully considered it, and understood it and went to the canary and so forth. But for the life of them, they couldn't figure out how to make it work out. There was just no way to do what he had been told to do, and he returned to the wise old owl for some advice about what to do next; how should he go ahead and make real the advice he had been given.

The owl said, "Ah, my role is analysis, not implementation."

(Laughter.)

Well, there is a certain fear. I don't know how grounded the fear is, but there is a certain fear that the professional cadre that lives on and works for the government in energy analysis tends to be in the analysis business, as we would view it professionally which is a substantial challenge, but might not be quite aware of what happens next when the work is done.

So, the point of this symposium is not only to have an opportunity to have a peer review of the work, the people who will speak to the report are perfectly capable of that, but to bring together the many different interests, if I could use that word in a neutral way, that deal with energy, both in terms of its current situation and analysis of what may become of it and find out how it looks to them. How is the report received from these various points of view. That's what I hope comes out. That was what was in our minds.

If you look at the people who are going to have a chance to talk over the next two days, really, I think, a successful attempt to bring many different points of view besides simply academic points of view to the microphone to tell you how it looks to them.

I think, from our standpoint, that is very important because, in a way, even though we are staff in the government working in the executive, this is a handicap because we tend to understand what the executive wants very well. It's set up explicitly for us to understand that, and we tend to respond to the Congress, as best we can, and understand what they are doing. Generally speaking, the report that we published can come to anyone and, perhaps, the major benefit of the volume that is published each year or so, really, arises due to its use by people that we are not taking into account on the first order in an explicit sense, because we don't know about them.

There may be things we should have in mind, but do not, that would very much help the nation get the most out of the money it spends in government to have this worked on. So, the idea, from our standpoint, is to find out more about that, if we can. That is part of the purpose of this gathering.

CHAPTER 2

ANALYTIC OBJECTIVES AND STUDY DESIGN

SPEAKERS:

Dr. George Lady, Energy Information Administration
Dr. W. Charles Mylander, Energy Information Administration

DR. LADY: I do want to talk about what was in our mind when we went about the analysis in the report. We are operating under constraints as well, and it is important that these be understood, so that the work that is done is accepted in the context it's intended to be accepted in. I would like to briefly discuss some of those constraints, because that would be our side of the interaction that we're hoping for. Then, as we go along, over the two days, people who have a more detailed understanding of the particular decisions we make will be here, and you can ask them how it is going.

So, let me then, just talk a little about the analysis frame that we limited ourselves to. You might ask me about it at the end but I will then try to get out of the way, and we can get on with the important part of the symposium.

First, let me say something obvious. It's that if you undertake an analysis of this magnitude, it is going to have a logistics tail to it, between the time you have done it and the time the book is in the hands of someone who can use it. There is a lot of time in that lag. As a result, it must be true that the analytic work stops at some point, and there is always the danger that something, which is very material to what you're trying to deal with, occurs between the time that the analysis is done and the time the report is published. That is always true in one sense or another. It is particularly true in the case of this report, because some of the events in the world market for petroleum, particularly the price increases in that market occurred after we had stopped doing the work, and were essentially doing editing and other logistic kinds of tasks.

It's certainly alright for people to call attention to that, but there is a limited value to telling us the things that are important after we had done the analysis, because that is obvious. There's always a list of such things. So, I hope we don't spend too much time discussing the fact that we did not take things into account that were unknown at the time that the work was done.

Perhaps, more interesting, we are really looking for good advice. If you look at the sequence of reports of which this is the last, it starts with the Project Independence Report, and then a report called the Energy Outlook, then a report which was called the same thing which did not get published; then finally, last year's annual report, there is a sharp dividing line in the theory of what the report is trying to accomplish.

Originally, the energy information that was being generated, if you will, in the report; the forecast; the analysis of the forecast; that was differentiated with respect to the policy option menu that the analysts understood to be important to the issues of the day. So that you are looking in the report at a very large number of different outcomes that the analytic group discerned would be related to different policy options. That was the point of it.

Well, when the Department of Energy was formed, there was a fair amount of concern for the independence of the energy information function. Part of that concern boiled down to a decision not to consider in an overt way, what was current to the report's preparation, and not to analyze the topical considerations, in that sense.

The reason was, that whatever you did had to, de facto, be biased in some way. Whatever was in your mind, if you look at some options in particular, you necessarily are not looking at somebody's version of those options. Surely you will leave something out. So, the facts will be biased, in that sense. Some interest in the policy debate will be represented well, and some will not be. The idea was that the energy information function in government should not serve one interest at the expense of another, but to serve all equally as far as possible.

So, the decision was made not to have a rich structure of different energy system scenarios, driven by policy distinctions. This was true of last year's report. Instead, the decision was to understand what the law was, at the end of the year, the first of next year, that the annual report to go with respect to those laws.

That is easy to say, and conceivably was the right thing to do; but there are several disadvantages in doing that. One disadvantage is that some laws, which are true now, expire about the time future years arrive, where you want to make a projection. You have to figure something out in that case. Do you just, literally, ignore the legal initiative in some area, because it, on the books strictly speaking, will no longer be there; or do you try to make a guess? Well, you have to make some judgment, and we made judgments and you should be interested in those; and, as we go along, find out what they are. Further, the law sometimes leaves discretion in its implementation; particularly in a regulatory environment. We had to, in such situations, make some kind of guess as to what the regulators would do. Strictly speaking, the law did not force us to do what we decided, but we had to make up our own minds. You should worry about that a little bit. We tried to be neutral, but neutrality is, perhaps, beyond us. Finally, there is a trend in law-making as a possible advantage in environemtnal standards. For example, you could easily guess that in future times the trend will continue and the law will be more stringent and so forth; but to ignore this as we have, what you do is you compromise.

To a degree what you are doing is predictive. I mean, you know for sure in some areas that what you're doing under the constraints I have described is not a best guess about what happened. Even under the "what if" nature of the scenario. You know it's not a best guess, because the law will move and you can understand how it would change; and we decided not to do that.

One thing -- one important thing from the standpoint of my interest -- might be some good ideas about this problem. Is there some way to behave differently in the way we structured the analysis, so we still maintain, legitimately, a neutral posture in terms of the various interests that we might serve; yet, do a little better with some of these issues, be a little more predictive? I don't know. That would be a wonderful thing if we could understand that kind of problem better.

In any event, the main idea is to get the different points of view available to us. There will be a document from this that all of you may get. Hopefully, with no intention of degrading what we will do here, the value of what we do here is greater than what we accomplished in the room in two days, but the document and the interactions will become far more substantial.

As we go along, if there is some obvious way to improve matters, you should say what they would be, because I think this is such a compelling idea that we will surely try to do it each year, unless some disaster befalls the attempt this time. So, we look for any suggestions to make things better. With that, I will thank you for being here, and will be out of the way, and turn the floor over to Charles Mylander.

DR. ALT: Before Dr. Mylander comes on board, and before I introduce the moderator for this morning's session, George spoke of disasters. I think this is an appropriate point to tell you that there are, by necessity, several changes in the outline for today.

(Laughter.)

The first, due to urgent preparations for a U.S. Treasury Department meeting with the President of the United States, Mr. Borkman will not be able to address us. Furthermore, due to the House Subcommittee on Energy and Power deliberations concerning the Iranian crisis, Mr. Finnegan will also not be able to address us. So, because we were not informed about this until late yesterday afternoon, the time did not permit us to find replacements, nor for them to suggest replacements. But we do feel it is best to continue the symposium agenda with the following changes for time.

If we work backwards, if we look at the Midterm Energy Supply and Demand, it was scheduled to start at 10:50; it will now start at 10:20, but will still run until lunch time, until 12:00 noon.

Short-Term Supply and Demand, again, will now run from 10:15 through 10:20. You say, "Why so short?" I won't steal thunder from that, and I'll let the speaker tell you why.

The coffee break will now run from 10:00 to 10:15, and Analytic Objectives and Study Design will continue until 10:00. Before Dr. Mylander speaks, I would like to introduce the moderator for this session, who is, I consider, a living legend in this area; namely, Saul Gass.

DR. GASS: Thank you very much, Frank. If I had known I was going to get a session with two speakers to go from 9:00 to 10:00, I would have gotten my soft shoes on to do a soft shoe dance.

George, in his introduction, went on and brought us into the first session; so George's comment should be taken as being the first speaker in that particular session. It's my pleasure, now, to introduce Dr. Charles Mylander.

Before I do that, let me just comment; because we do have some time, you'll notice these things that you have in your packets. I think it's a very good opportunity to ask George and Charles some questions; some of the plans they have had; some of the plans they have for the future. So, if you would write out these questions, I would be more than happy to address the questions to the individual speakers during this particular session.

So, let me go on and introduce Dr. Charles Mylander, who is Director of the Office of Integrative Analysis at EIA. Charles?

DR. MYLANDER: Our plan of presentation has been disrupted by events. Especially, the Iranian events of early November, which have affected three of our speakers. I was going to discuss our plans for the upcoming Annual Report to Congress (ARC). Work on this study has just begun.

I will present our current plans on how we're going to structure the scenario designs for the forthcoming report, and the organization of the forthcoming ARC report.

This meeting is being held in a timely fashion. We can redirect, to some degree, the way we organized the report and the issues we tried to address; the way we design our scenarios. I plan to leave time so we can have a useful discussion on these topics in the time that has become available to us.

But to put that discussion in a context and also to put into context the presentation of last year's annual report, which is called Annual Report to Congress 1978 or more colloquially, ARC-78; let me turn the floor back to George Lady, who is one of the chief architects of the design of last year's base case scenarios and participated in decisions on how to organize the presentation of last year's annual report, though I don't think he would accept the blame or the credit for being the primary architect of that report.

Dr. Glassey was the primary architect of the ARC-78 report. He, unfortunately, is unable to be with us today.

DR. LADY: I mentioned what we did not do, which was to have the analysis carefully investigate differences between government energy policies as they might evolve in the future. Instead, we tried to accomodate the idea that the results, however they were derived, were certainly uncertain as to their predictive quality.

As a rigorous matter, although it is easy to say, it is very difficult to understand the analysis process that we used; precisely, how to proceed and develop rigorous notions of forecast uncertainty. It is easy to define these notions, perhaps, but in a large system, such as we use which embodies many different modules, some automated, some not, and a considerable amount of judgment, to go ahead and end up with a textbook kind of uncertainty measure has, so far, been beyond us.

Nevertheless, due in part to the direction that was coming to this work from the two men that came in the senior positions in the new department, it was an assignment, both last year and this, to somehow accomodate that issue; and somehow let the user of that report understand the degree to which, in fact, there really was a range of energy prices and quantities, rather than just a single prediction under the various circumstances that were to be studied.

To do this, what was decided was to take the standpoint of an economist's view of what's going on. From the economist's standpoint, what in the end is being done, as far as the analysis is concerned, is that sharp estimates of energy supply, in the sense of alternative quantities of energy that will appear in the national markets at given prices, are achieved and sharp estimates of energy demand, which would be the quantities of energy that would be consumed at various prices in the national market.

Those estimates are brought in hand, and then due to quite a bit of effort, these two concepts are integrated and you come out with, given all the preconditions, prices and quantities for the energy system under the various circumstances that particular scenarios represent.

The price and the quantity in the energy market, surely, were in dispute in some sense, rather than clearly accurate projections. In order to represent uncertainty, in a second best sense, the various factors underlying supply and demand were perturbed. For example, on the demand side, a major determinant of what you would suppose would be demanded in a marketplace, insofar as consuming energy is concerned, is the overall level of economic activity as might be measured by national income, Gross National Product, depending on which product you're looking at.

As a result, that, as well as other variables that we would believe would be determining energy demands or influencing it, were perturbed. That is, different growth rates of the economy were assumed and we have, therefore, several demand structures that we would use. Each one related to an alternative assumption about economic activity, among other things.

In the same fashion, on the supply side, such as the cost of finding and listing oil and gas would, unquestionably, be important factors in an estimate of how much these energy sources would be processed and brought to market at a given price in that market. Again, variables such as these were perturbed. In any event, we would therefore, have several demand structures, as an economist might say -- supply structures or supply curves set in a simple sense. Then a scenario was defined by simply combining one of the demand structures with one of the supply structures.

The base scenario, which was the midpoint of these perturbations, was defined as a reference point; then, essentially, we had scenarios that investigated a high demand with low supply, high demand with high supply, et cetera. What comes out of doing this is the five scenarios you see reported. The idea of those was to generate some kind of range within which the analysis is offering future energy prices and quantities in a predictive sense and getting us out of the business of having a single prediction that we are trying to hang our hat on. This has been tremendously useful, I might say. Not to me so much, anymore, since I am unhappily not involved in an important way in this good work; but letters comes in the mail which say you're low or you're high, or both. And you're wrong, therefore, because our numbers are different than your numbers. In the old times, a lot would happen next. There would be a great scramble to find out what happened, and why. This still goes on, but now we can say, "No, no. See how your estimates fall within our ranges?"

Therefore, we are jointly consistent and we can go together and find out why you are on the high side of our range, but we are together, rather than adversaries. This is very constructive in what happens next and some interested party questioning the difference between their conclusions and ours.

So, that is the basic rationale. and the purpose of doing it that way was to try to understand, so to speak, the fuzziness associated with predicting the future in the matters that we are trying to do; so rather than, as I said before, trying to understand the different things government might do and then try to figure out what difference that makes.

Therefore, the scenario structure was really all about one effort which was to forecast energy prices and quantities in the future. The different scenarios are not different situations, but they are of the same situation. That is, it is our effort to look in the future and give an understanding of the range. That was in our minds when we did it, and that is what we intend you to take the scenarios to be.

DR. MYLANDER: One of the purposes in our scenario design is to try to identify a range of uncertainty in our forecasts, but clearly, in a limited number of scenarios, we were unable to completely identify the range of reasonable uncertainty in the forecasts.

The scenario designs did not vary certain factors that have significant uncertainties. For example, the scenario designs in ARC-78 do not really identify uncertainties about electricity prices, because we have certain behavioral assumptions built into our forecasting procedure that describe the way utilities will bring on-line new power plants and retire old power plants. This assumption affecting electricity prices and oil imports was not varied in the base case scenarios. We did try to address some of the uncertainties of this type, in what we call sensitivity analysis as distinguished from our base case scenarios.

Base case scenarios are an attempt to get a fully integrated forecast that is self-consistent, both from its description of the energy markets and the energy markets interaction with the economy, to the degree that we are analytically able to achieve that goal.

The sensitivity analyses do not try to achieve that ambitious goal, but rather look at the effect of changing one or two key assumptions and leaving everything else in a base case scenario untouched. Then making what we call only a partial, equilibrium analysis.

This year, based on comments we've gotten -- not in a form like this, but from people who call up and talk to us or write in their comments -- and we decided to proceed with a simpler scenario design for our base case scenarios. We're going to focus attention on only three base case scenarios instead of the five used in ARC-78. The key feature of the new base case scenarios is an attempt to use a reasonable range of uncertainty about world oil prices.

When we started trying to define these scenarios, two months ago,--- what I thought intuitively was a reasonable range of uncertainty on world oil prices and indicated by the studies that we have under way at that time might be overtaken by events that are occurring right now.

What we assume, as a reasonable high range on world oil prices, is lower than the current spot market price for reasons I don't fully understand. It seems we are approaching the upper end of our range of uncertainty for 1990 in 1980.

(Laughter.)

The major factor to be varied amongst the three base cases for the next ARC forecast will be world oil prices.

Another way of looking at the three scenarios is that we will have a mid-case scenario which will correspond to last year's mid-case scenario with high oil prices called the C-High scenario. A high world oil price scenario will be a pessimistic scenario. Then there will be an optimistic scenario that has low world oil prices that has the flavor that what happened in 1973 is going to, again, happen in 1978. You had an initial jump in world oil prices. Then world oil prices remained relatively constant and even declined somewhat in real terms before, again, the world production capacity is constrained by world demand and the scene is set for another increase in world oil prices.

A motivating factor in reducing the number of base case scenarios that we're doing is the desire to do another study in parallel with the annual report forecasting study. That other study is being done at the request of the Congress to examine the impact of energy regulation on the energy markets.

Another motiviation factor for reducing the number of base cases is that a fundamental purpose of our annual report scenarios is that they become base cases for doing policy analysis. When we are requested to do a policy analysis for either the executive branch or for Congress, we attempt to structure that analysis about an ARC scenario. That is, we try to analyze that policy as a variation of one of our base cases and then identify the impact of that policy by looking at the difference of the two forecasts: a base case forecast and the forecast that represents that proposed policy.

For the purpose of policy analysis we seldom use anything other than our middle case scenario, the C scenario, with the exception, this year. In the ARC report being discussed here we report on two scenarios in addition to those George has previously identified. They were done at the request of the policy branch of DOE to provide them with what they thought would be significant base case scenarios. We did something that is akin to what is proposed as the main line of this coming year's forecasting effort. We did two variations of the mid-case scenario, which have been identified as C-Low and C-High.

C-Low had low world oil prices remaining constant at $15.00 a barrel and then increasing only modestly to $16.50 in 1995. That case has not been the subject of a great deal of attention. The people, now, seem to identify our C scenario where world oil prices remain constant, at $15.00 a barrel until 1985, then increasing to $18.50 in 1990, and $21.50 in 1995, to be a low scenario.

Last year's high scenario, and world oil prices increasing to $21.50 in 1985 and going up to $31.50 in 1995. When we defined that scenario last year, we were very fearful that we would be criticized for considering such an outrageously high world oil price. Now that scenario in many people's minds is what they call the mid-case. Policy people look upon it as a middle case. They would like to have a much higher case study; how to protect the nation against high world oil prices.

Another thing that we can usefully discuss today is our perception that the Annual Report to Congress is too large; as you know, it is a thick volume reporting our forecast in three different time frames. A short-term forecast which went out the next three years, to 1982. The midterm forecast which covered the span from 1985 to 1995 and the long-term forecast which was a forecast of energy markets from the year 1975 to the year 2020. The focus of the long-term forecast is the past 2000 period.

The subject of the symposium, the 1978 Annual Report to Congress, was published in June 1979. The organization of this report is an international chapter, followed by three overview chapters looking at the different time frames I have just described. Then detailed chapters thereafter, focusing on the energy supply markets, the energy demand markets, and energy conversion industries such as the refining industry.

There is a chapter on the electric utility industry; a chapter on nuclear power; and several impact chapters that look at the impact of the energy future on the economy, on the regional distribution of income, and on the environment. The proposal for this coming year is that the current format is not serving the public and Congress well. We believe it would be more useful to have a smaller, more compact, document that is unified in its presentation.

The proposed new format is to have the international chapter, followed by the three forecast chapters. The three forecast chapters would be expanded only modestly. Most significantly, expanding the long-term forecasting chapter. The material in the chapters that discuss the various segments of energy supply and demand markets will be folded into the forecast chapters.

So, the material presented about the midterm forecast would not be as great as in the ARC-78 report. But it would be a unified presentation with everything together. Then we would have the separate reports which would be issued about the same time as the Annual Report, that is, an analysis of impact of regulations on the energy markets.

Both George and I went a little longer, but I think we can, now -- I'll turn it back to the moderator and hope to get some feedback on the issues we've raised already.

DR. GASS: Thank you, Charles and George. Are there any specific questions that the audience might have right now? Yes, please. I was wondering if it's a specific question, because we're trying to record it; if you would write it down with your name so we can get it in the proceedings. Thank you.

Do you have a question?

PARTICIPANT: Yes. Are copies of the report going to be available so we can have access to them before the meeting?

DR. GASS: Do we have any here?

DR. ALT: No, we do not have extra copies, here. They are very expensive.

DR. MYLANDER: Let me answer that question. Single copies are or were, until the print runs out, available at the National Energy Information Center, which is a part of the Energy Information Administration. I'll take it upon myself to get that telephone number. You can call them and request that you be sent a copy. (Single copies can be requested at the National Energy Information Center, (202) 634-5694.) Multiple copies have to be obtained by ordering them through the government printing office. As a member of the audience indicated, they are fairly expensive.

PARTICIPANT: I have checked that option out, and those copies are all gone, except for volume one. They referred me to the warehouse out here, that is on Highway 1. That's the only way you can get one, I'm quite sure.

DR. GASS: Thank you. I was wondering if I, in my perrogative as Chairman, might ask a question to George and Charles? I was just wondering if you would explain the relationship between the report results and the model development at EIA. Not so much between the current report, but what are you going to do in the future in trying to have people track the results and the models that we used to develop the results?

DR. LADY: From the standpoint of making available the basis of the report, itself, we have a program with several prongs.

The first is the idea that basic analytical capital that we use, or models, almost certainly reside on a computer. We have a program, now in place, of describing, and in some sense justifying or at least explaining, our reasoning behind choosing these systems as the way to do whatever they do. This is very expensive, as you might easily guess, so we have not done it all. We are in the process of doing it. We expect that soon, this year or next year, we will, in general, have available adequate descriptions of these models.

Of course, the models are used in various ways, but what the models do provide in terms of results are often amended. Judgment sometimes has to be inserted due to circumstances of models not taking things into account, as would be natural.

We also have a program for organizing all of this activity and also providing it. This is somewhat harder to do, because the same people who are to do this are the ones who are coping with the flow of assignments that naturally arise.

Whether or not we can do this quite as soon as the other, I don't know, but we are trying there, too. Further, we have an initiative that we are pursuing, but all of the applications are not fully understood at this point, which is to make the models, the intellectual capital that is on the computing machine, available to others.

Simply stated, this would entail having a tape and instructions and some reason to believe that those two things, together, are sufficient to enable a third party to accept the tape in the book, and understand what to do with it, and actually do it.

The ins and outs of that are considerable. Many of which are beyond my expertise. We are trying, however. Further, we have a number of projects and, as it is now anticipated, these projects will grow, both in number and magnitude, which as an analytic effort on the side of the production of the results, will consider the quality of the results.

Essentially, the projects evaluate and speak to whether or not the manner in which we are doing things is up to the state of the art; trying to take the various procedures that we use and experiment with them to understand sensitivities and other intuitive questions that you would want to have the answers to when you try to interpret the results in this report. That should be available around the first of February, perhaps. That is our intention. Yes?

PARTICIPANT: What rate of inflation do you incorporate in your model, specifically in projecting the price of oil? The reason I asked this is that I recently heard a paper by an economist from the Princeton Institute. He pointed out that in real dollars, the price of OPEC oil has not increased since the original jacking up in 1973.

Since then, he has a very interesting projection to show that the price actually did decrease from time to time, until OPEC jacks up the price again. In fact, it will have to be increased again, before the end of this year for the prices to remain constant in constant dollars.

DR. LADY: All prices in the analysis are "real". I am really the wrong person to deal with the question in that level of detail. But 1979 prices --

DR. MYLANDER: 1978.

DR. LADY: The prices are regardless to what year to which they are in contemporary. So, the prices in 1990 are in units of 1978 dollars. Thus, rates of inflation are not an essential part of the analysis, partly for a good reason; because with the exception of situations where the government is intervening via regulatory structure, from the standpoint of economics, the rate of inflation doesn't make any difference to what the analysis is doing. It would, though, be true, for example, that time track of a price in real terms, which showed the price declining,we assumed it to be constant. In nominal dollars that would be right.

Do you want to speak more to that question?

DR. MYLANDER: No.

DR. LADY: Does that answer your question?

DR. GASS: Thank you, George. Any other?

PARTICIPANT: It seems to me that there is something really basic between monetary units and constant dollar units, and when you assume constant dollar units you implicitly assumed that the bulk of the industry -- energy industry is interested in energy production, solely. What if a large portion of it is also interested in speculation?

DR. LADY: What about it?

PARTICIPANT: You have the rights to the reserves and those reserves--they are like any speculator. What is going to be the value in the ground tomorrow versus producing them today? So you have a speculative element that is involved in the market which is highly influenced by gambling instincts and so forth, versus the productive aspect of the market. When you put everything in real dollars, it seems to me that you are assuming that virtually all of the major factors in the market are in there for production.

DR. LADY: No, that's not right.

DR. MYLANDER: Let me have the first crack at this one, and then you can have the second.

(Laughter.)

You're referring to what I hear economists around EIA talking about -- it's not, well --

(Laughter.)

We're trying to address this issue, and perhaps after I have my say and George has his say, we can ask John Pearson, who has been working on this issue in connection with the long-term forecast, where it is an important issue. He can have his say, representing the EIA side.

We believe that there is some element of what you say in coal prices that people have to be paid more, right away; more than you would think, just on a pure, maximized, immediate profits basis to get the coal out of the ground; that they have a choice of holding the coal in the ground and selling it in the future at a higher price, or selling it now.

Natural gas and oil, it's not so clear for on-shore production from a natural gas reservoir, or a crude oil reservoir. If you don't take it out of the reservoir, your neighbor may. You have to worry about the fact that your neighbor, who has a well down the road, is going to take it out and he'll drain your reservoir. So you have an incentive to produce, even though, you know, if you withheld that production, you could get more for it. You could, perhaps, sell that oil for more in the future, but you have to worry about the fact that if you don't sell it now, you won't have it to sell in the future. Your neighbor will drain the field.

Off-shore, you have to worry about government regulations; you might have to give up your lease if it became clear you were withholding.

PARTICIPANT: What percentage of the reserves that is owned by these seven large companies versus the ordinary person -- the small person in the business, because the large person -- these large companies own the whole fields?

DR. MYLANDER: No, I don't believe that's true. There are unitized fields, where the owners of the fields have gotten together to control the rate of production. The stated purpose being to maximize the production over the life of the field and whether they are able to collude in a way that -- you know, a number of people must be able to collude in a non-public fashion to control production to withhold to produce in the future instead of maximizing the use of the life of the field.

This is not so clear. On-shore, many people hold the mineral rights. so even if the company -- one of the seven sisters is managing the production, slowed production and colluded with some other oil company down the street who had other mineral rights, they would be subject to suit, I imagine.

They would be hurting the person who they are paying royalties to. Off-shore, there are much bigger blocks, and you might control or a single operator might control it, an oil field. It would be less clear is the case.

John, do you want your say -- George, do you want your say?

DR. LADY: Can I answer the question?

DR. GASS: Sure.

DR. LADY: To summarize what was said -- and I think to understand the question -- the resource owner has two kinds of incentives that he is with respect to. One is a current account incentive from the standpoint that accounts for the profitability of bringing the energy product to market and selling it. I took that for what you meant by production orientation. Another in the accounting, you might call capital accounting incentive, which would be the degree to which it is profitable to hold the resource, because its price is going up; really relative to other prices and to holding the resource, you would show a capital gain.

It is conceivable that the capital gains aspect of holding the resource are more substantial than current account gains to selling it.

So, in fact, a resource -- a price of market. That is true. You can ask, and don't ask me the degree to which the oil and gas, the fossil or any energy supply modelling does or doesn't take that into account. That's a good question.

All of that is independent of whether or not you use constant dollars. There really is no relationship at all, because the issue is whether or not the price of the resource is increasing, in real, rather than in nominal terms. So, if the analysis is proper and we believe that the price of oil, for example, will increase in real terms, then in constant dollars, that's really just the choice of units in which the price is expressed. Whether or not you have nominal dollars or real dollars, it's independent of the analytic issue you raise.

PARTICIPANT: I don't agree, necessarily, because there is a financial aspect in there. People in financial circles, they pay in current dollars, right? Or the dollars at the time. Borrowing against -- you have debt considerations; you have credit considerations and it seems to me that adds another dimension too --

DR. LADY: No, unless there is something non-economic involved, which is the case in instances where the government is regulating. Inflation does make a difference in a regulated environment. Sometimes, however, the rate of interest, if it's doing its job properly, is going to completely neutralize this feature, because the contracts at the time will take all of this into account and the distinction between holding for capital gains and producing is absolutely, from a legal standpoint, insensitive to the contemporary rate of inflation; whatever it may be.

So, from the economics, constant dollars just do not - you have a good issue, but it is not really related to constant dollars versus nominal dollars. I don't believe.

DR. GASS: We have time for one more. Yes, please.

PARTICIPANT: I have a question. I think Mr. Mylander probably — you described you were going to design three base scenarios; one mid, one high, one optimistic. In the high oil price scenario, you suggested it will also be pessimistic in regard to other sources of supply. Don't you think it would be better to have a scenario that has high oil prices to be optimistic about other sources of supplies, so you could see how well alternative technologies and other sources of supply react to a high world oil price scenario?

DR. MYLANDER: I think maybe I'm trying to say the same thing and didn't say it very well. I don't know whether you're alluding to the trade-offs between fossil fuels and what are called non-renewable resources and renewable resources.

What I was trying to define was a scenario with high world oil prices. We're not being pessimistic in the factors that influence other renewable resources. So that if you look -- the criticism that we've gotten is that in all of last year's scenarios that we show electricity prices do not rise very rapidly.

Electricity prices are the most slowly increasing prices in our forecast. In real terms, they increase at less than one percent per year. Natural gas prices under the scenarios that we defined last year are the most rapidly increasing prices. Oil prices are in the middle. In a high scenario, like we might define in the future, oil prices might be more rapidly rising than natural gas prices. But the criticism is because we have this factor that we weren't pessimistic on things that affected electricity prices.

Your renewable resources don't compete against electricity at the prices we forecasted. If they became efficient in competition with the fossil fuels, oil and gas in particular, they still counldn't compete against electricity. Electricity prices were kept down because you had in the forecast a rapid replacement in the late 80's and 90's of plants generating electricity, oil-fired plants and gas-fired plants -- we have large coal reserves in this country. We didn't include such factors as withholding coal production, which is conceivable.

So, coal prices went up fairly slowly. Electricity prices went up fairly slowly. If you're interested in studying the trade-off between renewable and non-renewable, I agree with you; a scenario that is pessimistic about factors effecting electricity prices is needed.

PARTICIPANT: I was thinking, not just of renewable, but alternative technologies, let's say coal gassification, coal liquefication, and just looking -- looking at a scenario that,given high world oil prices, experts -- so called experts say that you'll have a world oil price of $35.00 a barrel; other commercial technologies are feasible. Why not have a scenario that looks at the -- not only renewables, but these other alternative technologies and see how much they could have an impact on the energy picture?

DR. MYLANDER: I think we addressed that fairly well in last year's forecast, both in the midterm and the long term.

PARTICIPANT: Well, for example, although I probably agree with you, you did it in the case of solar show a very small amount of heating that is direct solar, less than a quad, I think, and there were less than 1.8 quads from oil shale. I tend to agree with you, but maybe what you're referring to is that solar is giving such a small amount of energy, where the advocates would say, "No, no, no, how did you arrive at that conclusion to keep solar so small for heating, not for electricity?"

DR. MYLANDER: You mean disperse solar space heating?

PARTICIPANT: Going directly into residential, commercial, some industrial, mostly residential, commercial displacing oil and gas.

DR. MYLANDER: I think we discussed that feature of the demand in the mid-term; I'll let the demand people address that. I consider that a demand issue. We did attempt to address it. I think, maybe, part of the weakness, there, is in the write up of the annual report, rather than what was done analytically.

DR. GASS: I'd like to stay on time as best we can, so I'd like to close this opening session. Why don't we take a 15 minute break. We'll start in again at 10:20.

CHAPTER 3

SHORT-TERM ENERGY SUPPLY AND DEMAND

Speaker:

Dr. R. Gene Clark, Energy Information Administration

DR. GASS: For the rest of this morning, we have two sessions. One on short-term energy supply and demand, and the other on midterm energy supply and demand which will go over to this afternoon.

To start out the discussion on short-term energy supply and demand, we were to have Dave Hulett but I believe Dave is over in Paris. We're very fortunate to have Gene Clark from the Office of Energy Source and Analysis from EIA to describe their particular program.

DR. CLARK: Well Dave had hoped to be here this morning, but he was needed in Paris. He fortunately was not able to make it to our symposium.

As you can see from the program, the discussion of short-term is rather short. Five minutes allocated to this. Primarily, the reason for such limited attention is that the methodology, and even the organizational structure within EIA for carrying out the short-term analysis activities, have evolved and changed significantly since the annual report was published. Just prior to publication of the annual report last year, the short-term analysis activities were carried out, not under one organizational element, but through cooperation among several divisions and offices within EIA. This year, however, we have formed a short-term analysis division in the Office of Integrative Analysis. All the short-term analysis functions have been placed in that office.

In terms of critiquing last year's report, I'm afraid that most of that critiquing would fall on deaf ears, if it were directed at our office. So, I would like to refer anyone with specific comments or suggestions for how this analysis should be carried out to Frank Hopkins. Frank can be reached at 633-8720. He is the Division Director for the Short-Term Analysis Division.

In summary, the short-term analysis for this last report to Congress was carried out in January and February and, thus, did not include a lot of important considerations (similar to the case of the midterm analysis). In other words, there was no consideration of President Carter's April 1979 announcement, no March 1979 OPEC price hike, no Iranian production short-falls. These are some very important factors in the short term. But there were three essential scenarios developed that incorporate variations in such things as energy prices, level of income, weather changes, vehicle fuel efficiency, oil and gas production, and the availability of nuclear generating capacity.

Some summary features in this report to Congress are that energy consumption in the U.S. was projected to increase at rates on the low side of .2 percent per year over the 1979-1980 period, and a high of 3.1 percent.

Coal production and consumption increased significantly, ranging between 5.3-7.9 percent. Most of this consumption was in the electric utilities area. Petroleum product consumption levels ranged from an average annual decrease of 1.8 percent per year over the short term to a high annual increase of 4.2 percent, on the average.

The level of oil imports ranged between a decrease of 7.1 percent per year to an increase of 8.9 percent per year. So, you see, we covered a fair range there. This is compared to a 7.9 percent increase on the average, in the period 1976 to 1978.

As far as the methodology is concerned, since the methodology is being changed significantly, I would like not to address that point unless there are questions from the audience. If there are any questions, I will try to find the appropriate people to which to refer them.

Are there any members of the short-term analysis division here in the audience?

(No response.)

Shucks, I was going to point them out to you, so you could continue discussions at lunch, but I guess that will not be the case.

DR. GASS: Thank you very much, Gene.

CHAPTER 4

MIDTERM ENERGY SUPPLY AND DEMAND

SPEAKERS:

Dr. W. Charles Mylander, Energy Information Administration
Dr. T. Takayama, Energy Information Administration
Dr. Terry H. Morlan, Energy Information Administration
Dr. Clopper Almon, Jr., University of Maryland
Dr. E. A. Hudson, Dale Jorgenson Associates
Dr. Jamie J. MacKenzie, Council on Environmental Quality

DR. GASS: We have three speakers from EIA for this morning's session on midterm energy supply and demand. Our first speaker you've already met, Dr. Charles Mylander from the Integrative Analysis area. Charles?

DR. MYLANDER: Before I get into the discussion of the midterm forecasting we made in the annual report to congress; I would like to take this opportunity to say that the newly formed short-term forecasting division is busy, hard at work and has just recently produced a very interesting and extensive forecast for the rest of this year through all of next year, It's a forecast called "The October Short-Term Forecast" that is in printing right now. Copies will be available through the National Energy Information Clearing House; calling them, you can get copies.

They won't be out, yet, because this is the first group outside of Congress that is well aware that that forecast is now available. The schedule calls for the next short-term forecast, after this current one, to be available in January 1980. Then after that, one will be made about once a quarter.

What I'm going to talk about today is the midterm forecast made in the Annual Report to Congress that we are discussing. I was, at that time, in charge of the Midterm Analysis Division that was responsible for coordinating the production of that forecast. At the current time, the responsibility for the forthcoming forecast is in the hands of Dr. Julie Zalkind, who is here, attending today. You might stand up so people will recognize you.

She would be a useful person to talk to during coffee breaks and when we get together for lunch, if you want to carry on a conversation about the midterm forecast; either how it was done last year, or how it is going to be done in this coming year. Julie was a key analyst in doing last year's forecast and now has responsibility for it. To, hopefully, refresh people's minds because the time allotted to me is very short, I would like to quickly review some of the key points of the forecast and then discuss some of the key subjects under which the forecasts were made; then briefly discuss the procedures we use to make the forecasts.

So, to review the forecast, I'd like to begin by looking at the mid-case scenario, in the context of the history and the forecast period. May I have the first slide?

(See Table 4.1)

The mid-case, the C scenario here, is mid-supply; mid-range projections on economic growth. So, that defines the midterm demand. For every parameter that was ranged in making the forecast, this projection represents the middle of that range. An important feature of our forecast is we try to put equal effort on forecasting quantity as well as forecasting prices.

This is a table of forecast of quantities. It's in quadrillion Btu per year. We see coal production doubling between 1979 and 1990; and increasing at that same rate through 1995. Coal is the domestic resource which will be most rapidly increasing.

Gas, we see, had reached a peak in the early 70's. It is declining through 1977. The decline continues in the forecast period, though the rate of decline is somewhat arrested by the passage of the National Energy Act and the gradual decontrolling of gas that the act included.

We have, what many people might consider an anomaly, as they look at the projection of oil production; that it reached a peak again, in

Table 4.1. U.S. Energy Supply/Demand Balance;
History and Series C. Projections, 1962-1995
Medium Supply, Demand, and Costs
(Quadrillion Btu Per Year)

	Historic				Projected		
	1962	1967	1972	1977	1985	1990	1995
Domestic Supply							
Coal	11.21	14.19	14.49	15.90	22.69	31.22	41.70
Gas	13.72	17.94	22.21	19.57	18.19	17.40	17.08
Oil	17.11	20.83	22.64	19.78	21.79	23.07	23.96
Nuclear	0.03	0.09	0.58	2.70	6.57	9.43	12.66
Other	1.81	2.35	2.90	2.42	3.24	3.49	3.97
Total Domestic Production	43.88	55.40	62.81	60.37	72.48	84.61	99.38
Net Gas Imports	0.40	0.49	0.97	0.98	1.88	2.04	1.57
Net Oil Imports	4.20	4.90	9.83	18.22	17.42	16.96	16.36
Net Electricity Imports			0.08	0.18			
Total Supply	48.48	60.79	73.70	69.75	91.78	103.61	117.31
Disposition							
Residential	7.76	9.05	10.54	10.29	10.77	11.39	12.00
Commercial	4.72	6.28	7.77	7.87	7.55	7.91	8.33
Industrial*	17.16	20.00	22.63	22.16	28.23	33.18	39.44
Transportation	11.25	14.19	18.15	20.15	21.00	21.89	23.32
Total Consumption	40.88	49.52	59.08	60.47	67.55	74.36	83.08
Conversion & Distribution Losses	6.39	9.35	13.65	15.86	22.33	27.17	31.95
Stock Changes	0.12	1.13	0.25	2.15			
Net Coal Exports	1.09	1.37	1.50	1.40	1.90	2.08	2.28
Total Disposition	48.48	61.37	74.49	79.79	91.78	103.61	117.31

*Industrial sector includes losses incurred in refineries & synthetic plants.

the early 70's; started a decline, and then we show that an increase occurs through the forecast period. A major portion of that increase is a result of the assumptions that decontrol will occur by 1981, that is an incentive--that along with the price increases that are assumed. Price and decontrol also are the incentives for the enhanced oil recovery. Our projections include a rapid growth in enhanced oil recovery; particularly by thermal methods, which are a well established technology, but it has its drawbacks.

There are particularly some environmental drawbacks. However, we believe, the prices will be high enough that the environmental problems can be overcome. The nuclear forecast will be discussed in detail tomorrow. The forecast through the 1990 period is constrained by nuclear plants that are currently in the pipeline.

The 1995 forecast is constrained by non-economic factors; reasonable assumptions about the trends in the construction of new nuclear power plants. That will be discussed in great detail tomorrow in the nuclear session.

PARTICIPANT: I don't understand--in your table, the last two figures for oil for 1990 to 1995 show a slight upward trend, again; but in the same period, gas is tracking downward.

DR. MYLANDER: Yes.

PARTICIPANT: I'm not quite sure, could you explain what that effect is due to?

DR. MYLANDER: There will be a discussion of oil and gas supply projections tomorrow that will get into this more deeply. A quick answer is just repeating what I've said is, that part of the large portion of the increase in oil production will be due to enhanced oil recovery using such things as thermal recovery techniques, and recovering heavy oil which does not have much natural gas associated with it.

So, the increase in that increase in production doesn't result in any increase in gas production. The increase in oil production coupled with some conservation measures coming into effect would cause a decline in oil imports.

Could we move the slide up a little--there will be a more thorough discussion of trends in the sectors of residential, commerical, and industrial. Notice the rapid rate of growth in the industrial sector. The way we believe the world works, increased industrial energy demand, is tied to increasing growth in the economy. Then there is modest growth in transportation demand. The growth rate being slowed by increasing fuel (especially caused by vehicle standards) efficiency, but not arrested.

Let's turn to the next slide.

PARTICIPANT: Before you do, I'd like to make a comment. In your next report, is it possible to make an effort to break out the non-electric--I mean the non-energy uses in the industrial sector. That is, feed stocks, petroleum for plastics, and so forth?

DR. MYLANDER: Okay. In addition to the volume I held up in my hands before, we have this big, fat volume which is called "The Supplement to Volume III" which gives the detailed regional aspects and use aspects to our forecast.

Our forecasting methodology is one of building up a national forecast from regional detail and end use detail. From this volume, you could identify the amounts of fuel that are going to be used as petrochemical feed stocks, and to be used as refinery fuel. Also, it breaks out more clearly the fuel projections for electric utilities.

PARTICIPANT: Because I note there, that your total supply and your total disposition match; is that a desired disposition or a constrained disposition?

DR. MYLANDER: We're leaping ahead. The forecasting methodology is one that we forecast equilibrium conditions at the point where energy supplies equal energy demands.

(See Table 4.2)

These are some of the key prices given in our forecast. Coal prices are increasing modestly. The assumed price path for world oil really drives domestic oil prices. What we see in here is an increase in refinery acquisition costs which, again, relates to the assumption of decontrol of crude oil prices by 1981, which is part of our scenario design assumption.

The most rapidly increasing price, as shown on this projection is natural gas prices, both at the wellhead and in the end use sector. The increase in residental gas prices is less than the rapidly increasing natural gas prices to industrial users. This phenomenon occurs as a result of an assumption about implementation of the Natural Gas Policy Act which passes increased gas purchase costs first to industrial users. The costs of "high cost gas" first flow to industrial users. Let's turn on to the next slide.

(See Table 4.3)

The next slide shows the range of forecasts for 1990 under the different scenarios. The five base case scenarios are A through E. As described by George, they are different combinations of assumptions about supply--things that affect the supply curve and factors that

Table 4.2 U.S. Energy Prices,
History and Series C Projections, 1962-1995
Medium Supply, Demand, and Costs
(1978 Dollars)

	Historic				Projected		
	1962	1967	1972	1977	1985	1990	1995
Supply Prices (Minemouth or Wellhead)							
Coal ($/ton)	9.65	8.91	11.67	22.01	26.46	29.81	33.45
Bit.,High Sulfur-W.VA.	*	*	*	*	8.87	9.54	11.46
Sub-Bit., Low Sulfur-WY							
Oil ($/barrel)							
Texas	6.45	5.79	5.29	*	15.09	18.83	23.83
Imported-Landed U.S.	4.55	4.29	4.05	14.40	15.00	18.50	23.50
Avg. Refinery Acqu. Cost	*	*	*	12.85	14.82	18.15	23.19
Natural Gas ($/million Btu) (Marginal Price)							
Southwest	*	*	0.47	1.94	2.18	2.40	2.96
Demand Prices							
Residential							
Electricity (cents/kWh)	5.10	4.16	3.50	4.00	4.19	4.34	4.43
Distillate ($/gallon)	0.29	0.28	0.27	0.47	0.51	0.60	0.74
Natural Gas ($/million Btu)	2.14	1.94	1.80	2.42	3.47	3.85	4.27
Transportation							
Distillate ($/gallon)	0.45	0.46	0.45	0.63	0.63	0.72	0.86
Gasoline ($/gallon)	0.64	0.63	0.55	0.67	0.86	0.95	1.07
Jet Fuel ($/gallon)	0.24	0.23	0.22	0.39	0.54	0.62	0.74
Industrial							
Electricity (cents/kWh)	2.10	1.87	1.90	2.50	2.98	3.17	3.28
Resd. Fuel Oil ($/barrel)	7.48	6.98	7.61	15.40	17.85	21.53	25.94
Coal ($/ton)	24.30	20.30	23.85	33.98	39.07	41.47	44.19
Natural Gas ($/million Btu)	0.71	0.66	0.73	1.47	2.63	3.12	3.87
Industrial Surcharge ($/mil.Btu)	0.00	0.00	0.00	0.00	0.09	0.24	0.53
Raw Materials							
Natural Gas ($/million Btu)	*	*	*	*	2.45	2.81	3.27
Average Price ($/million Btu)							
All Fuels--All Demand Sectors	*	*	*	*	5.06	5.61	6.27

*Not Available.

Table 4.3 U.S. Energy Supply/Demand Balance, Projection Series A-E for 1990 (Quadrillion Btu Per Year)

Assumptions	Historic 1977	Projected A	B	C	D	E
Supply Curve		High	Low	Mid	High	Low
Demand Curve		High	High	Mid	Low	Low
Supply						
Coal	15.90	33.31	33.71	31.22	28.62	28.70
Gas	19.57	17.91	15.50	17.40	17.23	15.19
Oil	19.78	29.56	21.69	23.07	29.08	20.21
Nuclear	2.70	10.02	9.16	9.43	9.90	9.07
Other	2.42	3.50	3.60	3.49	3.48	3.59
Total Domestic Production	60.36	94.30	83.66	84.61	88.32	76.76
Gas Imports	0.98	1.77	2.48	2.04	1.89	2.03
Oil Imports	18.22	16.99	17.26	16.96	12.65	17.69
Electricity Imports	0.18					
Total Supply	79.75	113.05	103.40	103.61	102.85	96.48
Disposition						
Residential	10.29	11.80	11.06	11.39	11.60	11.12
Commercial	7.87	8.95	7.50	7.91	7.98	7.31
Industrial	22.16	36.10	33.59	33.18	32.59	30.95
Transportation	20.15	24.18	21.62	21.89	21.38	19.42
Total Domestic Consumption	60.47	81.03	73.77	74.36	73.55	68.79
Conversion & Distribution Losses	15.86	29.13	26.73	27.17	27.18	25.61
Stock Changes	2.15					
Coal Exports	1.40	2.90	2.90	2.08	2.08	2.08
Total Disposition	79.79	113.05	103.40	103.61	102.81	96.48

affect the demand curves.

So, over the range of uncertainty on oil supply there is a fairly large range. The supply projections in the A scenario assumes the very optimistic projections made by the USGS about recoverable reserves. The C case has their mid-estimate, then in the E scenario, we have their low estimate of recoverable oil reserves.

Let's turn to the next slide.

(See Table 4.4)

Corresponding to the 1990 quantities, these are the price forecasts. The variations on quantities showed the widest range was between the A and E scenarios. The widest variations occcur on the price projections between the B and D scenarios, where the prices are more heavily influenced by demand considerations.

I talked briefly, earlier, about the two variations of the C scenario. Could I have the next slide which has the same supply and demand assumptions as the C scenario. The major features of these projections is assumption variation in the cost of imported oil.

(See Table 4.5)

The variation in oil production is caused by a producer's response to seeing different oil prices. Can we see the next slide?

(See Table 4.6)

Here, we have the range of prices. One of the features is that electricity prices, say, for any given year are not very greatly affected by different assumptions about world oil prices, because imbedded in our forecast is the assumption utility will build new coal-fired plants when it is economically attractive to do so.

Table 4.4. U.S. Energy Prices;
Projection Series A-E for 1990
(1978 Dollars)

Assumptions	Historic 1977	Projected A	B	C	D	E
Supply Curve		High	Low	Mid	High	Low
Demand Curve		High	High	Mid	Low	Low
Supply Prices (Minemouth or Wellhead)						
Coal ($/ton)						
Bit.,High Sulfur-West VA.	22.01	26.15	35.06	29.81	25.07	32.05
Sub-Bit., Low Sulfur-WY	*	8.58	10.45	9.54	7.99	9.68
Oil ($/barrel)						
Texas	*	16.32	23.83	18.83	15.34	21.36
Imported-Landed U.S.	14.40	16.00	23.50	18.50	15.00	21.00
Average Refinery Acqu. Cost	12.85	15.80	23.19	18.15	14.78	20.63
Natural Gas ($/million Btu) (Marginal Price)						
Southwest	1.94	1.99	3.27	2.40	2.01	2.79
Demand Prices						
Residential						
Electricity (cents/kWh)	4.00	4.09	4.75	4.34	3.98	4.61
Distillate ($/gallon)	0.47	0.53	0.73	0.60	0.52	0.69
Natural Gas ($/million Btu)	2.42	3.57	4.28	3.85	3.60	3.99
Transportation						
Distillate ($/gallon)	0.63	0.66	0.84	0.72	0.64	0.81
Gasoline ($/gallon)	0.67	0.89	1.08	0.95	0.85	0.99
Jet Fuel ($/gallon)	0.39	0.57	0.74	0.62	0.54	0.70
Industrial						
Electricity (cents/kWh)	2.50	2.91	3.58	3.17	2.81	3.44
Resd. Fuel Oil ($/barrel)	15.40	19.04	26.77	21.53	18.07	24.96
Coal ($/ton)	33.98	37.76	44.69	41.47	37.02	43.76
Natural Gas ($/million Btu)	1.47	2.63	3.94	3.12	2.66	3.48
Industrial Surcharge ($/million Btu)	0.00	0.12	0.52	0.24	0.09	0.39
Raw Materials						
Natural Gas ($/million Btu)	*	2.51	3.35	2.81	2.53	3.02
Average Price ($/million Btu) All Fuels-All Demand Sectors	*	5.14	6.41	5.61	5.01	6.04

Table 4.5. U.S. Energy Supply/Demand Balance,
Projection Series C-High and C-Low for
1985, 1990, and 1995
Medium Supply, Demand, and Costs
(Quadrillion Btu Per Year)

	Historic 1977	1985 C-High	1985 C-Low	1990 C-High	1990 C-Low	1995 C-High	1995 C-Low
World Oil ($/barrel)	14.40	21.50	15.00	21.50	15.00	31.50	16.50
Supply							
Coal	15.90	23.86	22.46	33.64	28.71	42.65	37.05
Gas	19.57	18.81	17.66	18.29	16.69	17.72	15.41
Oil	19.78	22.06	21.71	25.78	21.89	27.49	20.87
Nuclear	2.70	6.54	6.56	9.46	9.47	12.70	12.70
Other	2.42	3.28	3.24	3.48	3.50	3.98	3.98
Total Domestic Production	60.36	74.55	71.64	90.66	80.26	104.53	90.02
Gas Imports	0.98	1.54	1.88	.95	2.06	1.00	2.53
Oil Imports	18.22	12.30	18.98	7.79	24.54	7.10	30.98
Electricity Imports	0.18						
Total Supply	79.75	88.39	92.49	99.39	106.86	112.63	123.53
Disposition							
Residential	10.29	10.49	10.80	11.17	11.61	11.54	12.39
Commercial	7.87	7.27	7.89	7.43	8.49	7.87	9.39
Industrial	22.16	27.18	28.52	31.88	34.21	38.52	40.76
Transportation	20.15	19.31	20.78	20.29	22.75	21.06	25.34
Total Domestic Consumption	60.47	64.26	67.99	70.76	77.06	78.99	87.86
Conversion & Distribution Losses	15.86	22.24	22.60	26.55	27.73	31.36	33.38
Stock Changes	2.15						
Coal Exports	1.40	1.90	1.90	2.08	2.08	2.28	2.28
Total Disposition	79.79	88.39	92.49	99.39	106.86	112.63	123.53

Table 4.6. **U.S. Energy Prices, Projection Series C-High and C-Low for 1985, 1990, and 1995 Medium Supply, Demand, and Costs (1978 Dollars)**

	Historic 1977	1985 C-High	1985 C-Low	1990 C-High	1990 C-Low	1995 C-High	1995 C-Low
World Oil ($/barrel)	14.40	21.50	15.00	23.50	15.00	31.50	16.50
Supply Prices (Minemouth or Wellhead)							
Coal ($/ton)							
Bit., High Sulfur-WVA	22.01	27.05	26.09	30.94	28.75	33.88	30.94
Sub-Bit.,Low Sulfur-WY	*	8.87	8.87	9.54	9.54	11.78	10.57
Oil ($/barrel)							
Texas	*	21.59	15.09	23.85	15.35	31.83	16.82
Imported-Landed US	14.40	21.50	15.00	23.50	15.00	31.50	16.50
Avg.Refry.Acqu.Cost	12.85	21.15	14.80	23.22	14.87	31.32	16.42
Natural Gas ($/mil.Btu) (marginal price)							
Southwest	1.94	2.55	2.11	2.59	2.21	3.14	2.48
Demand Prices							
Residential							
Electricity (¢/kWh)	4.00	4.40	4.17	4.42	4.25	4.46	4.33
Distillate ($/gallon)	0.47	0.67	0.51	0.73	0.54	0.93	0.59
Nat. Gas ($/mil. Btu)	2.42	3.62	3.39	3.89	3.70	4.36	3.99
Transportation							
Distillate ($/gallon)	0.63	0.79	0.63	0.84	0.67	1.05	0.71
Gasoline ($/gallon)	0.67	1.03	0.86	1.07	0.85	1.27	0.91
Jet Fuel ($/gallon)	0.39	0.69	0.54	0.74	0.56	0.93	0.61
Industrial							
Electricity (¢/kWh)	2.50	3.16	2.95	3.23	3.09	3.30	3.16
Resd.Fuel Oil ($/bar)	15.40	24.35	18.03	25.37	19.27	33.77	20.86
Coal ($/ton)	33.98	39.79	38.69	42.32	40.47	44.75	41.85
Nat. Gas ($/mil Btu)	1.47	3.00	2.52	3.44	2.83	4.24	3.07
Industrial Surcharge ($/mil Btu)	0.00	0.29	0.09	0.46	0.14	0.79	0.11
Raw Materials							
Nat. Gas ($/mil Btu)	*	2.64	2.39	2.92	2.66	3.38	2.96
Avg. Price ($/mil Btu) All Fuels-All Demand Sectors	*	5.83	5.04	6.12	5.23	7.00	5.55

*Not Available.

In 1985, you cannot build new coal plants that are not already in the advanced planning stage or construction's already begun. In our forecasting procedure, we do assume that new coal plants can be built in 1990 and 1995, as needed and where it is found to be economically desirable as we evaluate the economics within our forecasting procedure.

So, we have in 1990 and 1995 a fairly wide variation in coal production, about 60 or 70 percent of this variation is in response to variations in demand for coal by electric utilities for generating electricity. Next slide please.

(See Table 4.7)

Now, I would like to talk about a few of the key assumptions that underlie all the projections and didn't vary by scenario. Okay, as I've already mentioned, we assumed crude oil prices would be decontrolled by 1981. Legislation that is in place only permitted crude oil prices to be controlled through 1981 and then it goes away. We made the heroic and somewhat questionable assumption that there would be no new crude oil price controls.

We were very vague in how the process would occur to lead us from where we stood last January to decontrol crude oil prices by 1981. Our forecasting procedure is not particularly sensitive to this portion of the price path and how the decontrols would occur between January 1979 and December 1981.

PARTICIPANT: You're assuming that there is no wind-fall profits tax.

DR. MYLANDER: It should be pointed out that because we made the assumptions back last January before there was a very active debate of this issue that in the forecast there was no wind-fall profits tax. So that those projections increase in domestic oil production assumes that

Table 4.7. The Most Significant Assumptions Underlying All The Scenarios

- Crude oil prices are decontrolled by 1981.
- The alternative fuel cost for limiting the surcharge added to natural gas prices for low-priority users is set at the wholesale price of distillate fuel oil.
- There is a 130 percent lifecycle cost test for new, large oil or gas boilers.
- Natural gas prices to producers are limited, as specified by the Natural Gas Policy Act of 1978.
- Limited amounts of Canadian and Mexican natural gas and liquefied natural gas can be imported.
- The price of natural gas imports under new contracts is tied to the world oil price.
- The Alaskan Natural Gas Pipeline is completed by 1985.
- The Trans-Alaskan Pipeline can be expanded to a capacity of 1.6 million barrels of oil a day by 1985, and to 2.2 million barrels a day by 1990.
- The PACTEX oil pipeline is the only oil pipeline link connecting the West Coast to the midwestern and southwestern pipeline networks.

the decontrol prices and the profits that go with them go to the oil companies, or to the people who hold mineral rights for that oil.

For the assumption on implementing the Natural Gas Policy Act, we took a more conservative stance. We assumed that the default option in the legislation would be the one followed. We did not feel we could lead policy makers in deciding how to implement incremental pricing provisions of the Natural Gas Policy Act.

So, we assumed the "surcharge cap" or "the cost of the alternate fuel" would be distillate fuel oil. At the time we were doing our analysis, we assumed that natural gas would be incrementally priced to all industrial users; not to agricultural users, but to all industrial users, small boilers, large boilers, and for process heat. These assumptions will be changed for this year as the way that legislation is going to be implemented becomes clear.

To implement the provisions of the Fuel Use Act, we assumed that what the regulators had proposed last year would be the way that they would implement this act. That there would be a cost test based on life-cycle cost. We've allowed exemptions for building new oil- or gas-fired boilers to meet environmental standards. The regulations, as they're now evolving, have now gone in a different direction.

Prices paid for the different categories of natural gas are considered in our forecasting procedure; and limited by the provisions of the Natural Gas Policy Act. We do assume Canadian and Mexican gas could be imported. We assume that the imported price would be tied to world oil prices. Our forecast of what Mexican and Canadian gas prices would be increased as the world price of oil increased.

The price we forecasted when oil prices are between $18.00 and $20.00 turns out to be pretty good; except we didn't forecast those oil prices occurring in 1980. We assumed that they would occur in 1985 or 1990. The price of liquified natural gas for new contracts is tied to the world oil price. We did not make the assumption that the El Paso 1 gas contract would be tied to the world oil price, though apparently now, they've gone back on a retroactive basis and partially tied into world oil prices.

We assumed that the Alaskan natural gas pipeline would be completed by 1985. So, we show Alaska gas on the North Slope being produced. That was a questionable assumption now, and probably will not occur by 1985, is the way we perceive it now. It will occur by 1990, but not 1985.

We assume that the Alaskan oil pipeline could be expanded to accommodate modest increases in oil production there, either from new finds or new production or from Prudhoe Bay. The 1.6 looks very reasonable, now. The producers are now talking about expanding the pipeline to the 1985 capacity assumption.

The 1990 capacity assumption does look to be feasible, and probably the capacity would be expanded if we found reserves to justify that level of production. We did assume at that time that there would be crude oil pipeline from Southern California to the Gulf refineries. Obviously, that assumption will have to be changed. That is not going to come about. Next slide, please.

(See Table 4.8)

It is assumed domestic oil can be exported, which leads in our forecast--if you look at the regional aspects of our forecast (which

Table 4.8. The Most Significant Assumptions Underlying All The Scenarios

- No domestically produced crude oil can be exported.
- Petroleum-product imports are constrained to encourage the domestic refining of oil.
- The only new, coal-fueled electric powerplants that will be available in 1985 are currently in the planning stage.
- The rate-reform provisions of the National Energy Act do result in the use of time-of-day rates that improve the electric utilities' efficiency of operation.
- Nuclear powerplant construction is constrained by non-economic factors.
- Diesel cars achieve a 9.4 percent share of the market by 1985, and this share remains constant thereafter.
- Diesel light-duty trucks achieve a 7.8 percent share of the market by 1985, and this share remains constant thereafter.

are not discussed in the Annual Report to Congress, but do show up in the supplement), we show a West Coast glut because of both heavy oil production on the West Coast and availability of Alaskan crude.

So, the producers as represented in our forecasting procedure can either make the choice of paying about $2.50 to ship Alaskan oil around through the Panama Canal or they can sell it at a discount on the West Coast. That would depress the price that domestic producers could receive on the West Coast. After you back out imports on the West Coast so that imported oil no longer is setting the marginal price, it could result in lower petroleum product oil prices on the West Coast.

It is hard--I don't really understand why that doesn't happen now; why we don't see lower prices on the West Coast than for the rest of the nation. There are some anecdotal evidence that can explain it, but it doesn't go much beyond that.

We assume that the rate reform provisions of the National Energy Act would have some effect on the shape of the load curve and the efficiency under which utilities could operate. This assumption didn't turn out to be a major influence on our forecast.

One factor that we've had trouble picking up in our forecasting procedure was the penetration rate of diesel automobiles and light trucks. If you have a high penetration rate, then the diesel fuel prices that we forecast would be much higher than we forecasted. We assumed a fairly low penetration rate; and we show diesel fuel prices to be under gasoline prices.

There are two things that ought to be considered when you look at gasoline prices in our forecast versus diesel fuel prices. One is fuel prices. One is that gasoline prices are retail prices; the diesel fuel prices are a mixture of what are real retail and wholesale prices. They are prices paid by end-use consumers of diesel fuel, a portion of it is used by truck stops and as diesel fuel for automobiles; a portion of it is used by railroads, and truck and bus fleets.

Would you switch the projector off? I'd like to say a few words about our methodology for forecasting and establishing these prices. We used a very elaborate modelling scheme that represents supply curves and demand curves; then we try to establish the point where the supply curves intersect the demand curves. That gives us a forecast of both quantities and prices, so that our forecasts are neither constrained by supply or demand factors except as discussed in the assumption list.

There are assumptions that I haven't fully discussed. We have, therefore, one large computer model that does this integrating procedure. We have other procedures for estimating supply and demand curves.

We have people here who will discuss about how those demand curves are forecasted. Tomorrow, both the process of building those demand curves and supply curves will be presented in greater detail.

DR. GASS: Thank you, Charles. I'd like to hold the questions until the end of the period, so we get all of the speakers in first. The next speaker is Dr. Takayama from EIA.

DR. TAKAYAMA: My role in ARC-78 was almost nil.

(Laughter.)

When I started my EIA career in July of this year, the members in

EIA were celebrating their completion of ARC-78. I did not attend that meeting becuase I did not contribute.

But like it or not--my role now is heavily involved in the next round ARC activites. I have to put my full attention to the task of interfacing the demand side within the ARC effort.

However, what I would like to talk about today is a rather philosophical matter. Then, I will turn the podium over to my division chief, who worked on ARC-78. Detailed questions should be addressed to him.

Efforts in the large-scale modelling area have been going on for some time. Especially in the form in which the ARC-78 was conducted--using a mixed system. Theoretically, Mr. Samuelson started this business in 1962. In '64, I began working and publishing with one of my colleagues of the University of Illinois, George Judge. Our focus was on developing a programming methodology in the large-scale modelling area. In '71, we wrote a book which handled this programming method and the linear complementary programming method. What distinguished our model from other LP modelling was the fact that it was a market equilibrating model.

Large-scale modelling has its own momentum. OPEC started to make use of large-scale models, using British Petroleum data to crank out the reference price schemes that OPEC has used since then.

Other modelers joined in and started to crank out a tremendous amount of information from scale linear programming models.

Working as a consultant for OPEC, I tried to implement the linear complementary programming type scheme there, but it was not completed by the time I left in 1977.

Now, it is amazing that OPEC is using PIES' results or other results. I think they're really taking our large-scale model results seriously. Whatever we produce could affect their policy decisions and sometimes, I have thought, to play on Hamlet's famous line, "to forecast or not to forecast, that is the question."

The other day, I talked with Hendrik Houthakkar and said, "Do you know how much you infuriated the OPEC people when you published the Kennedy-Houthakkar paper? Because of your pessimistic projection for OPEC's prices in 1980, they really got mad and decided to squeeze, squeeze the Western countries, especially the United States."

He said, "I couldn't help it. That was the piece of information that I had. I used all of it, and the results were there."

If the Kennedy-Houthakker report was '73 reality, maybe '74 reality, according to PIES, was more realistic. If so, I think overall, the results form a rather favorable projection.

If you try to do projections as conscientiously as you can, you may get lost in the maze of realities, or you may be squeezed to produce something that may become another consensus in the end.

One staff member in my office just completed a comparison of our '77 results with other projections. He came up with the rather interesting conclusion that 1974 PIES' results for '77 were very encouraging and very close to reality; even closer than some judgmental forecasts.

Well, this controversy will last almost forever. There is a trade-off between model simplicity and the amount of money you spend in cranking out the numbers. Some people call these numbers useless.

Modelling in the demand area, when I started out in this kind of business, was based on, say, commodity by commodity type analysis. Now we ask, in modelling on the supply side, can it be modelled on a commodity by commodity basis? Sector demand, that is the residential, commercial, transportation, and industrial sectors; these four sectors play an important role.

When we have some kind of share scheme to distribute the demand for each fuel used in a particular sector, this must be interfaced with the larger structure. Ultimate headaches start when analysts or economists working in my office look at the data side; when they find that the demand functions don't match with reliable coefficients. I turn this headache to Dr. Terry Morlan, a division director for my office. Thank you.

DR. GASS: Let me introduce Terry Morlan from EIA.

DR. MORLAN: Thank you. I would like to concentrate, for a fairly short time so we have plenty of time for discussion, on the methodology of the demand side of the MEFS system. The methodology isn't discussed in the annual report. Because it is an evolutionary methodology, it is sometimes very difficult, I think, for people to keep track of exactly how it is constructed.

In particular, a number of people who have attempted to evaluate the demand system found that they were evaluating something that, when they finished evaluating it, was no longer an operating system, but an obsolete piece of modelling history. I think that is a fact of life in any effort where you are trying to constantly improve your methodologies and your models and trying to address new issues.

If I could have the first slide, I would like to go briefly over the basic set of interrelated energy demand models, and describe how they were used for the ARC-78 forecast.

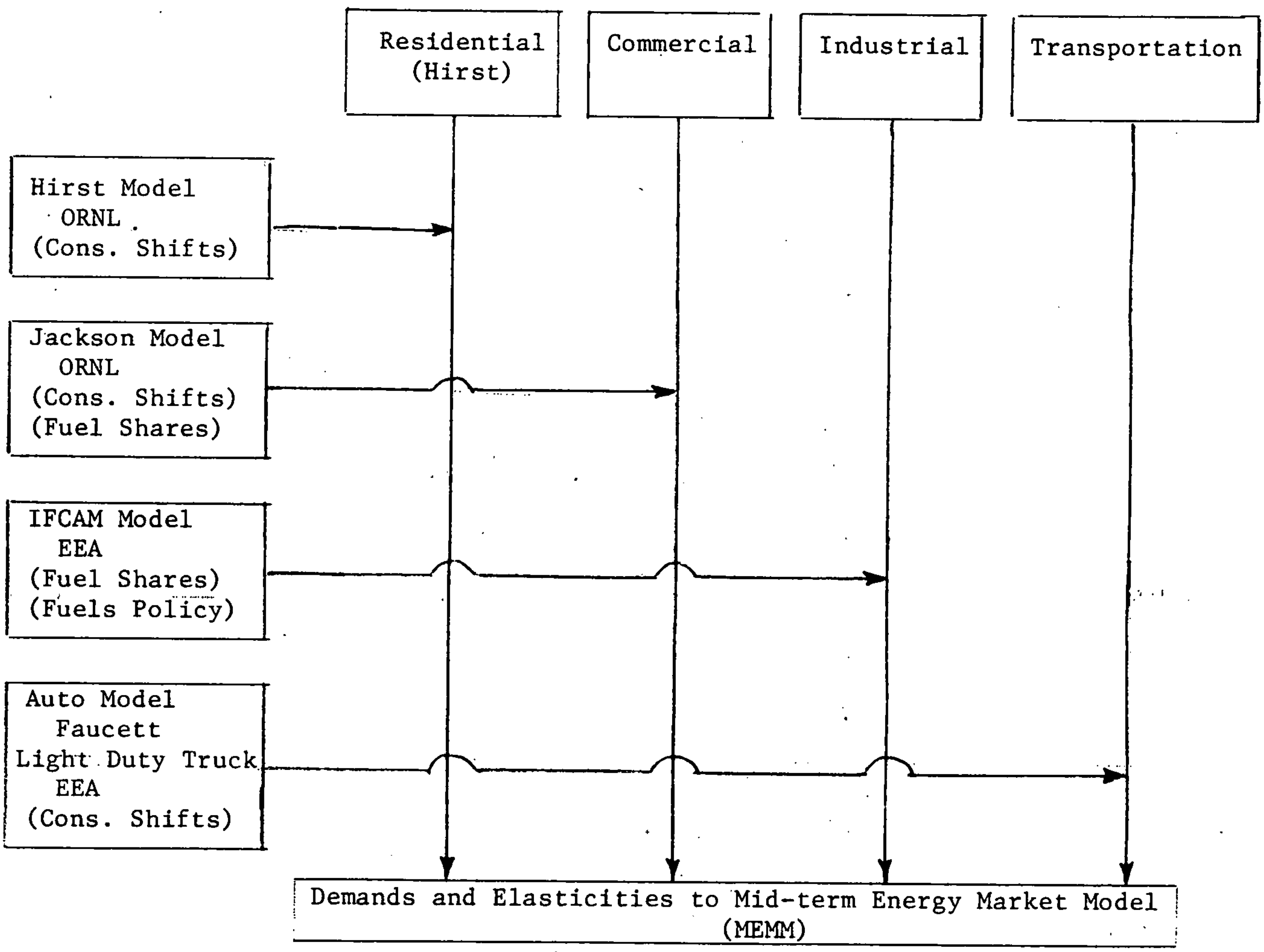
(See Figure 4.1)

I call your attention to the block labelled "RDFOR," but what that really is, is the core of the on-line demand analysis system. This demand system has gone through a continuous evolution from the time of the Project Independence Report, when it was a national level econometric equation model in a very reduced form. The evolution has included a couple of iterations through regionalization, improvements in the data base, and increasing fuel and sector detail. The system is evolving into a much more structural type of model.

It has been the case, in the past, that structural econometric models were used off-line in conjunction with the reduced form econometric on-line model. The structural/econometric models are necessary to address such matters as policy impacts.

Structural/econometric models are gradually being brought into the on-line system. Figure 4.1 shows the way it stands for the ARC-78 report. The Hirst model (the Oak Ridge National Laboratory Residential Model) is a structural/econometric model, which has been imbedded into the on-line system and was used in that form for this year's annual report. However, the evolutionary nature of the process is illustrated by the fact that the Hirst Model was also used in an off-line mode for the annual report to generate the impact of conservation policies in the residential sector. The reason for using it off-line, in addition to on-line, was simply that the staff in EIA had not had sufficient time

Figure 4.1. MEFS Demand Module (ARC78)



to learn to stimulate energy conservation policy with the model. That part of the analysis was done by ORNL personnel.

The block referred to as Jackson Model is the Oak Ridge National Laboratory Commercial Model, which is also a structural/econometric type of model. It was used this year off-line to adjust the fuel shares in the commercial sector. An econometric model, especially in the reduced forms, tends to have fairly large uncertainties associated with the forecast as the independent variables depart from their historical ranges. This was evident in the commercial and industrial sectors this year, with higher world oil price assumptions. The Jackson Model was, therefore, used for two purposes: first to take a control total from the reduced form econometric equation for total consumption in the commercial sector and break it down into the fuel shares; and second to analyze the effects of conservation policies in the commercial sector.

There was a similar situation in the industrial sector, where an off-line industrial model, the Industrial Fuel Choice Allocation Model (IFCAM) was used to determine the non-electricity fuel shares--override those fuel shares from the econometric model. In the transportation sector, two off-line models were used to assess the impacts of fuel economy standards. One addresses automobiles and the other, light duty trucks.

Now, where do we plan to go from here? It is expected that next year the Hirst model will be used entirely on-line and in addition, the Jackson commercial model will be used on-line for the annual report for '79.

We are not sure, at this point, what is going to happen in the industrial sector, but we assume we will be using a similar methodology to that which was used last year, with the exception that it will be more imbedded into the MEMM integrating model. In the transportation sector, we have new model, which is being developed at Oak Ridge National Laboratory, that disaggregates the automobile fuel demand more. It is econometric, but it contains state level detail and, in addition, it breaks out five different classes of automobiles. With this detail we get a much better idea of what is happening in the transportation sector and the extent to which people can make substitutions among different types of automobiles.

Could I have the next slide please.

(See Table 4.9)

Table 4.9 shows a history and projection of EIA demand modelling. It also indicates sources of documentation to the extent that they exist; and various reviews that have been done of the demand models over time.

The regional and sectoral aggregations indicated in Table 4.9 don't show the detail that I have been talking about in terms of the extent to which structural/econometric models are being integrated. However, it shows that for ARC-78, some structural components in the on-line model are used for the first time. The structural/econometric approach will receive increased attention in the future.

The progressive regionalization of the demand system is evident in the slide, but its future direction is unclear. In the past, there was a lot of demand for EIA to model at the state level, at least. In fact, it is required by legislation. However, the resources

Table 4.9. The MEFS Demand Module: History and Outlook

Major Analyses	Structure	Regions	Sectors	Documentation	Reviews
PIR	Econometric	National	R/C,I,T	PIR Appendix AII	Hausman MIT GAO
NEO76	**Econometric**	**Census**	**R/C,I,T**	**NEO76 Appendix C Nissen & Knapp**	**Waverman/RRF**
NEO77	**Econometric**	**Federal**	**R,C,I,T**	**NEO77 Appendix D**	
AAR77	**Econometric**	**Federal**	**R,C,I,T**	**Synergy, Inc.**	**TEAC/TNEMP Freedman/Sutch**
ARC78	**Econometric/ Structural**	**Federal**	**R,C,I,T**	**Synergy, Inc.**	**ORNL (Barnes & Nyugen)**
ARC79	**Econometric/ Structural**	**Federal**	**R,C,I,T**		
ARC80	Enonmetric/ Structural	Federal & State	R,C,I,T		

required for that type of analysis are quite substantial, and they haven't come forward to the same extent that the requests for state level analysis have come forward.

As an introduction to EIA's future energy demand models, let me talk briefly about reduced form econometric models and structural/econometric models. I would like to say a word or two about the distinction between those two approaches to modelling and why EIA is currently moving toward the later as a demand analysis and forecasting tool.

Reduced form econometric models relate your objective, which might be forecasting sectoral fuel consumption (such as distillate oil by the residential sector) to general economic effects, price effects, or other variables that you expect to be correlated with the objective. The actual mechanism, or the structure, for that effect being felt on fuel demand is not explicitly captured in the model.

The reduced form has some advantages and it has some disadvantages. The advantages are simplicity, partly, in the sense that you don't have a tremendous amount of detailed information. The relationships are fairly straightforward, but at the same time, you aren't able to say a great deal about why you are getting the result that you are, except that you can say, "Well, income is growing, and prices are going up; so, they have these effects on demand."

In such a model, the users don't get a feel for they energy system--why energy demand is related to income, and how it is that prices reduce energy consumption.

A more structural model tends to be oriented toward end uses of energy, and the way in which energy and capital are combined to provide end-use services. For example, heating in a residential or commercial building, or lighting, or vehicle travel in the transportation sector. Energy is an input to the provision of such services. There is an explicit capital stock, or a set of equipment, or buildings, or cars that are associated with providing those services. Those capital stocks have specific characteristics. They require investment to update and often they are the actual target of an energy policy, such as the fuel economy standards for the automobiles and efficiency standards or weatherization programs for housing.

Only by modelling this structure explicitly, can you directly get the effects of energy policy imbedded in the results. That's why structural/econometric models have traditionally been used off-line along with the reduced form econometric model.

In the time remaining I would like to summarize the nature of some structural/econometric models EIA has been using, or will be using in the future. Typically, in a structural model, you find there is a core equation that the model is built around. The core equation tends to be disaggregated across several dimensions.

A very simple example of a core equation is shown in Table 4.10.

(See Table 4.10)

This is the core equation of the Sweeney Automobile Gasoline Demand Model which has been imbedded in the demand model probably since the NEO-76.

The Sweeney model's core structural equation is simply that total vehicle miles travelled times the average gallons per mile of the fleet of automobiles give you total gasoline consumption.

Table 4.10. Sweeney Model Core Equation

$$G = VMT \cdot \frac{1}{MPG}$$

G = Automobile Gasoline Demand

VMT = Vehicle Miles Traveled

MPG = Miles Per Gallon

That's the core structural equation.

Then you start to break it down; vehicle miles travelled may be an econometric equation relating to income and the cost of travel. Then the efficiency, miles per gallon, could be related to gasoline prices or policies that affect the average fleet efficiency.

Table 4.11 shows the core equation for the Oak Ridge Residential Sector (Hirst) Model. The core equation in the Hirst Model is an identity that relates energy use to the housing stock, average size of the housing, the equipment penetration shares, thermal integrity of houses, equipment efficiency, and usage factors. But this particular equation holds across several dimensions. It holds across four fuel types, eight end uses, three different housing types; it holds for new or used housing; and it holds across ten different regions.

A similar characterization can be done for the Oak Ridge Commercial Model.

(See Table 4.12)

Table 4.12 shows a very simplied core equation for this model. It simply says that the consumption of fuel is equal to the stock of energy using equipment, expressed in potential energy use, times the utilization rate of that equipment.

This is a very simple concept, but the core equation disaggregates into a much more detailed representation. By disaggregating the concepts in the core equation, it can be expressed in a form very similar to the Hirst Model. In addition, the dimension of the core equation disaggregates across seven building types, four fuels, five end uses, and ten regions, and also accounts for the vintages of the equipment.

(See Table 4.13)

Table 4.11 ORNL (Hirst) Residential Model Core Equation

$$Q_t^{ikm} = HT_t^m \; HS_t^m \; C_t^{ikm} \; TI_t^{ikm} \; EU_t^{ikm} \; U_t^{ik}$$

i = fuel

k = end use

m = housing type

Q = energy use
HT = housing stock
HS = housing average size
C = equipment penetration share
TI = thermal integrity
EU = average annual energy use for equipment
U = usage factor

Dimensions

Fuels	(4)
End uses	(8)
Housing types	(3)
Housing states	(2)
Region	(10)

Table 4.12. ORNL (Jackson) Commercial Model Core Equation

$$Q_t^{ikm} = U(P)_t^{ikm} \cdot S_t^{ikm}$$

i = fuel type

k = end use

m = building type

$U(P)_t^{ikm}$ = utilization rate

S_t^{ikm} = stock of equipment

Q_t^{ikm} = energy use

<u>Dimensions</u>

Building type	(7)
Vintages	(annual)
Fuels	(4)
End uses	(5)
Regions	(10)

Table 4.13. ORIM Industrial Model Core Equation

$$\text{Carrier Use} = \frac{\frac{\text{Carrier}}{\text{Service}} \cdot \frac{\text{Service}}{\text{Output}} \cdot \text{Output}}{\text{Technological Change}}$$

Dimensions

Carriers	(6)
Industries	(9)
Energy services	(4)
Vintages	(10)
Service characteristics	
Regions	(10)

A more industrial model is being developed for EIA by ORNL. This model, the Oak Ridge Industrial Model (ORIM) also has a core structural relationship or identity. The structural identity is shown in Table 4.13. It simply states that a certain amount of energy service is required per unit of output, and that each unit of energy service requires a certain amount of fuel (carrier), and further, that these relationships may change due to technological factors. The power of this simple concept derives from the disaggregation behind the structure. The model applies to 9 manufacturing sectors, 10 capital stock vintages, 6 fuels or carriers, 10 regions, and 4 energy services. The energy services include: process heat, mechanical drive, and electric services. These services are further disaggregated to service characteristics such as, large versus small, intermittent versus continuous, and coal feasible versus coal infeasible. I think I'll stop there, and we'll try to concentrate on the questions.

DR. GASS: Thank you, Terry. Any specific questions on the subject matter for this session, or for any of the particular speakers? Yes, please, if you would speak up loud; I'd appreciate it for the transcriber and the people in the back.

DR. KNAPP: My name is David Knapp. I had a question for Terry. The way that the models have developed, I think, have been constrained by data availability. In order for econometrics to be done on the pieces of these process models, there has to be a lot of additional data work.

I'm wondering what kind of support is planned on end use data bases in terms of more engineering details being collected where it's necessary, and if the analysis is driving the data acquisition, or is the data activity following independent goals?

DR. MORLAN: Yes. That's a good issue. Both types of models, econometric and structural models, have severe data limitations. I think for structural models the data limitations may be even more severe because you're collecting and dealing with a lot more detail.

In some cases, the structural type models do have econometric drivers and in some cases they don't. For example, the Oak Ridge Industrial Model, in its initial form, will not have any econometrically derived parameters at all, which personally bothered me a little bit. But, on the other hand, it is designed to be a flexible modelling structure which can be expanded in any direction.

We're hoping we'll be able to improve the various structural models based on the new energy end use surveys that are being designed by EIA. The residential sector survey is in the testing phase now for a limited sample. The commercial energy use surveys should be starting, I think, in about a year. Then industrial energy end use surveys are being designed also. Such surveys will eventually provide much improved data. In the mean time, we have parameters in the models that, in some cases, probably have fairly weak basis, although they're based on the best engineering and data judgment available. On the other hand, by setting up the structures of these models ahead of time, we have had an opportunity to provide input to the design of the end use surveys. So, when those surveys become available, hopefully, they'll be much more relevant to our needs than they would be if we'd waited until they were available and then designed the models to fit the available data.

DR. KNAPP: Are they going to provide any historical depth, so that you can do econometrics on the end use consumptions, or are they just going to be point in time?

DR. MORLAN: They'll initially be a point in time. The historical depth will be developed eventually, but it will be a long way down the road before you have a very good basis for time series econometrics. You may be able, with sufficient regional detail, to do cross-sectional econometrics in some areas.

DR. GASS: Yes, please.

PARTICIPANT: What were the criteria for you to select the models?

DR. GASS: The question is what was the criteria for selecting the form of the model?

DR. MORLAN: I think I mentioned some of the criteria. A lot of it has to do with the types of policy incentives that we would like to be able to analyze. That's a primary reason for going to a structural/econometric type of model; to try to get the policy type effects.

In addition, it's important to get a feel for the capital investment and energy using equipment required in order to achieve energy efficiency improvements, and phasing in of those efficiency improvements over time. Therefore, we want models which account for the capital stocks of energy using equipment.

DR. MYLANDER: Terry, to follow up on that question, what role does the fact of econometric models, as you say, become more uncertain when you get out of historical price ranges; whereas, the structural models move that concern off at least one step and make you a little less vulnerable to that concern?

DR. MORLAN: ~~You get less~~ less vulnerable to that particular statistical concern, but on the other hand, one of the drawbacks of the structural model, I think, is they usually have a very explicit decision mechanism, such as minimizing life-cycle costs, implied in the model.

In a sense, that is probably a good hypothesis, and you'd like your model to reflect that type of analysis. On the other hand, there are an awful lot of other kinds of behavior out there in the economy that are affecting how people choose their equipment and so on, that have nothing whatever to do with life-cycle cost.

Probably, one advantage of econometrics is they capture that kind of behavior implicitly. It's for that reason, I think, that some combination of econometrics and purely structural approaches are the way to go. Hopefully, we get the advantages of both, and not the disadvantages of both when you put them together.

I think with careful design, we can manage that.

DR. TAKAYAMA: Let me chip in a little bit here--if you put the econometric and engineering models in a sharp contrast, you will see a distorted picture. We've got to realize that even the engineering-structural model has an econometric model in it. There is no conflict between econometric and structural models, and each has characteristic problems. To point out a few here: The structural approach, such as the Hirst or Jackson models, which generate a so-called reduced form representation of demand, can develop problems for a large change in price. A drawback in a pure econometrics approach is that we in the energy field are wandering into an observation space where observation never existed.

In our modelling framework, sometimes the solution just shoots up in terms of price, although there is no historical precedent. Maybe that is the time to put our hands together with other specialists and talk about plausible strategies that the economy may assume. We have no observations, so perhaps some economic common sense is the only thing we can rely on.

DR. GASS: Thank you. Any other questions? Yes, please.

PARTICIPANT: Do these models take into account the penetration of new technologies that come on-line during this period? Automobiles, solar process heat; that sort of thing.

DR. GASS: The question was did these models take into account the new technologies like solar, electric automobiles and the like?

DR. MORLAN: As a general rule, the answer to that is no. In terms of the model structure, however, the answer is yes; they probably could if you had enough information about those types of technologies.

Some of the types of models which can more easily take those into account would be, for example, some of the very detailed process models that have been developed at Brookhaven and other places for specific industries. To the extent that you know something about technology, the required inputs and its role in the process, you can provide it as an option to the hypothetical decision-maker in the model.

The decision maker will then select this new technology, when that is an optimal selection. Basically, the Hirst and the Jackson models don't have new technologies, specifically, in them at this point.

DR. MYLANDER: Could I follow up on that a little bit? On the new technology penetration problem is one of the bases that we distinguish between the procedures that we use for making our midterm forecast and our long-term forecast; the long-term forecast and procedures try to take that problem into more explicit consideration.

In the midterm, what Terry says is true. Our feeling or our justification is that the new technologies, such as electric cars and some of the more exotic things will have a very small impact in 1985. Even by the time of 1995, they'll not have a very large and significant impact.

But they will have an impact beyond that period, and that is why we have to use a different forecasting procedure. We do take into account in the structural models, such as in the Hirst model, technologies that were not very popular in the early 70's or before, but were known about; and now look like they're more economically justified at higher energy prices.

The Hirst model, for estimating residential demand, takes into account heat pumps that are improving efficiency and reliability. There is rapid penetration into the market and does take into account some of the new add-on technologies, for example, use in space heating by natural gas furnaces.

So that, you see, in our forecast, the residential demand for natural gas does not increase very significantly, even though we are assuming that the hook-up moratorium has ended and people can hook-up to use natural gas for space heating.

A partial explanation for that is the use of such a structural model as the Hirst model, does say that even though natural gas is available, because gas prices are rising and there is some uncertainty with natural gas that is picked up by the econometrics imbedded in that model; heat pumps will still continue to penetrate the space heating market, even though natural gas in most sections of the country will be cheaper on life-cycle cost basis than heating by heat pumps.

The other aspect of our forecasting procedure is, it does assume that there will be an increasing efficiency in gas furnaces, and there will be even some retrofitting of houses with gas furnaces, improved insulation.

PARTICIPANT: How about the old technologies like the wood burning stove?

DR. MYLANDER: No. It is not accounted for.

DR. TAKAYAMA: In appliance efficiency based modelling--the problem is how new are the new appliances, how new are the new houses? Do we have any information about this? If we don't, Hirst should not introduce that kind of thing.

In our residential and commercial models, we have appliance efficiency, furnace efficiency, and building energy efficiency so that we can capture some existing technologies which are likely to improve in efficiency in the future.

But brand new things like the electric car, that is a real new area. The majority of modelers, such as Fadden and Hausman, use a discrete choice model of some kind. I'm not sure how far we can go with that type of modelling unless we develop some kind of mechanism to trace the evolution of penetration instead of "bang we know the equilibrium state." We know the equilibrium probability that will eventually hold, only if prices are given and other attributes are known.

So, as you know, a wide range of challenging areas are open for us.

PARTICIPANT: In regard to your last comment, am I to take it that the models are not inherently dynamic in any respect?

DR. TAKAYAMA: Yes, That frame of modelling is not dyanmic; it was never claimed to be dynamic.

PARTICIPANT: Don't you have problems in ensuring consistency of solutions, then, from one year to the next?

DR. TAKAYAMA: You cannot pursue it that way. Given the price, assuming that the utility remains stable and unchangeable--unchangeable in structure--maybe you're right. But as the environment changes and the perceptions of people change about the attributes, maybe you're in trouble. That is my understanding.

PARTICIPANT: I think you both mean different things by dynamic.

DR. MORLAN: Well, if I could--I think there's a confusion about which models we're talking about. I think that Dr. Takayama was referring to the discrete choice models for the electric vehical rather than our models used in the Annual Report

PARTICIPANT: So, give me the full answer for your models, too.

DR. MORLAN: The models are inherently dynamic.

(laughter.)

That's not the full answer, but maybe that's all you want. The econometric reduced form models are dynamic in the usual sense of the lagged dependent variable. In the Hirst and Jackson Models, the dynamics are more explicit.

DR. MYLANDER: To follow up, this question of dynamics is a little bit more: the models used to make the supply curves and the demand curves are our dynamic models; they account for dynamics in econometrics or by tracking stock changes.

The forecasting procedure we use takes a snapshot approach for the years '85, '90, and '95. So, we take a snapshot of states of the supply world and states of the demand world in 1985; then do a static equilibrium analysis. This is done for each of the three years for which we made forecasts with a very minimal amount of accounting for capital stock changes. We try to account for capital stock changes in the area of electric utilities in the integrated forecasts.

If you go back and think about the forecast I showed, of imported natural gas, we showed gas imports declined between 1990 and 1995 in the Series C forecast. That decline is probably inconsistent with a dynamic view of the world. If contracts are written to import gas from Mexico or Canada or for liquefied natural gas in 1990, you will have to continue to import that gas in 1995.

So, there are some aspects of dynamics we're not picking up fully.

DR. ZALKIND: One more thing to add to this discussion of whether the model is dynamic or not. That is that the supply model and the demand model are dynamic. Then we run the snapshot equilibrium models. That isn't the end of the procedure. If the equilibrium forecasts are out of sync with the dynamic models, we go back and reiterate through this procedure.

So, in effect, the equilibrium models are consistent in the end with the dynamic supply and demand models.

DR. KNAPP: Another way to say the same thing is that the elasticities, which represent the demand model and the implied elasticities on the demand side are dynamic elasticities. They represent demand changes for a period of time. So, for '85, it would be a six-year elasticity. So, what that gives is some hidden dynamic structure.

DR. TAKAYAMA: Let me chip in. Old ideas and new ideas can mix sometimes. There has got to be an interface to make something more workable. I think this is a large area in which more thought, more theoretical thought, has got to be put in. From a theoretical point of view, I confirm what Charles said. However, we are not interested here in a purely theoretical model. To me it is a matter of proceeding with the convergence of the two, and which way to converge, if in fact there is some equilibrium point. But perhaps we should not dwell on this issue now.

DR. GASS: Yes. Thank you.

MR. LAWRENCE: Mike Lawrence, you provided a range of forecasts. Is it possible to provide, essentially, a confidence interval for any individual forecast?

DR. MYLANDER: Defining a confidence interval on an individual forecast is a desirable goal, but it has not been achieved. It's not foreseen that we will achieve that goal in the immediate future for the midterm forecasting system that we have been discussing. We're addressing that issue more fully in the short term. We have a model that permits us to move more quickly in that direction.

DR. LADY: Depending on the way you interpret things, one way to put it is they are not different forecasts, but they forecast together. So, there is a range. Therefore, we know we can pursue the idea of the question, but the intention of the scenarios was not to give you a different forecast, but to show you what the forecast was, taken collectively.

PARTICIPANT: Could you expand on that? It's not very clear what you mean.

DR. LADY: The intention of the work is to project energy prices and quantities in different points in time. The notion of uncertainty is the notion that any statement must be taken as not necessarily what is going to happen. The idea of uncertainty as a measured notion would be that you would give some range or band, treat the forecasts as a random variable, in some sense.

We know, as a fact, the way the model is structured that you could take a scenario and then model non-scenario parameters and make bands around the center, much as you asked had we done. It is technically possible. I can say it; I can say those words.

We did not do that for various reasons. Instead, we had a scenario structure which was designed to treat the pricing quantities in principle as random variables. So that the forecast is, in a second order sense, a qualitative sense, presenting you the random variable in a range.

You have to take the scenarios jointly.

PARTICIPANT: Do you mean the range A through E provides that?

DR. LADY: I do mean that. Prices are differentiated with respect to scenarios, B versus D, and if you had a price quantity space in some sense in the area bounded by the points given in each of those scenarios would, itself, be the forecast; for the forecast, now, is a random variable.

PARTICIPANT: That is not to say the elasticities are varied.

DR. LADY: As a technical matter, we did not arrive at that range by varying parameters in the model structures, such as elasticities. We did not. But it could be done that way; it was not.

PARTICIPANT: Conceptionally, one thinks of model structure when you vary A to E or varying the assumptions and keeping the model structure the same. I think my question has to do with a set of assumptions--how does a forecast vary as a function of the parameter estimates in the model structure?

DR. LADY: Well, as a matter of strict rigor, the distinctions you are making between assumptions and parameters may be a distinction without a difference.

PARTICIPANT: This is Econometrics 101.

(Laughter.)

DR. LADY: I do not know about that. There is a language appropriate to various disciplines, and that may be appropriate to what you do in an econometrics class, but as a matter of strict logic, you take certain beginnings and you transform them into what you offer as projections. You may choose to characterize some of your starting points as parameters; you may choose to characterize other of your starting points as assumptions. You may have good reasons for communicating these various starting points in those ways, but as a matter of strict logic, they are no different. What you assume a GNP may be versus what you assume a price elasticity may be, in one case termed an assumption and in another case termed a parameter.

Maybe this distinction is not, technically speaking, a very useful one when you get into problems expressing uncertainty. So, what you say is correct. There are variations that we did not attempt, which are easy to see as good candidates. Work is well under way in an effort to have a richer structure of variations, speaking precisely to the issue that you identified.

On the other hand, the point I have emphasized is that the scenarios are not different forecasts. Instead, jointly, they are intended in our mind to collectively represent the range of uncertainty around the projections that they represent.

DR. TAKAYAMA: We have discussed this many, many times. I still maintain that the scenario uncertainties are variable-based uncertainties. Structures didn't change, parameters didn't change; so, in a sense nothing changes. Sometimes we are forced to present it as uncertainty, but it is clearly variable- or parameter-based variations that we are generating.

We don't really know what kind of probability we can give to that kind of result. Maybe if we knew the combination of variables giving us some kind of uncertainty presentation in terms of a consistent probability, then we might be able to attach some kind of probability to each scenario. But that's all we can say; that the uncertainties are inherent in the structure; inherent to the econometric equations that we derived; uncertainties on all of the parameters that we have--we go through that filtering process.

We did not know; we did not have intelligent machinery that can produce a convolution of probability for all the events coming into it. I guess this is the toughest probability question that anyone can face in a large-scale modelling framework.

So, we might as well set it aside for the time being. You can attempt it, but it's a billion dollar question.

PARTICIPANT: It is a very difficult problem, but I don't think you can write it off by saying that the scenarios A through E, essentially, answer the question. They don't.

DR. TAKAYAMA: But we have done it many times.

DR. GASS: It sounds like a good topic for lunch.

DR. TAKAYAMA: With Alka-Seltzer!

DR. GASS: I should comment that DOE/EIA is doing a bit of research on that problem. There are people in the audience that are working on it. They might want to address that with the gentleman here.

Let me close the session. We'll start in again at 1:00 P.M. in this room. This morning we heard from the EIA people. This afternoon, we'll hear from the people who are critiquing the ARC report.

Thank you very much.

(Whereupon, at 12:00, the meeting recessed for lunch, to reconvene at 1:00 that same day.)

AFTERNOON SESSION

(1:05 p.m.)

DR. ALT: Good afternoon. If we could get started now, I'd like to welcome you to the second half of the first day of the symposium to critique or review EIA's 1978 Annual Report to Congress.

Several things have come up over the lunch hour that I'd just like to point out to you. First of all, about the proceedings, Volume III. As I mentioned earlier, we had some difficulty obtaining these ourselves, but they were available at the Government Printing Office on Route 1. The cost for Volume III is $8.00.

Furthermore, by tomorrow, we hope to provide everyone with a list of the attendees. Also, some of you may be unaware, but there will be proceedings of the remarks made at this conference. That's why it's extremely important that if you do ask a question, we would like you to precede the question with your name, so that your name could appear in the proceedings; unless you wish to remain anonymous.

(Laughter.)

So, with that, I'd like to start this afternoon session. I also want to point out that, right now, we're continuing with the midterm energy models. Those of you, perhaps, who are here that are not familiar with modelling techniques, but do have a feel for what the actual numbers should be; if for some reason you disagree with the numbers that are projected, please bring that out.

So, don't feel you have to be an expert modeller to comment on some of the results of the report. As Saul mentioned this morning, we are now going to turn the other side of the coin and let non-EIA people comment on the report.

Our first speaker in this session is Professor Clopper Almon, who is a full professor in the Department of Economics at the University of Maryland.

DR. ALMON: Can the formal discussions remain anonymous?

(Laughter.)

I'm afraid that I am identified; benefitted; or suffered from the problem of getting copies of this. My own arrived on my desk on Monday afternoon. I was committed all day yesterday. I got to work at it at 9:00 last night.

I've worked at it rather constantly since then. I have not entirely succeeded in understanding the modelling procedures on the midterm forecasts. I am, therefore, going to resort to somewhat the techniques suggested; that if you have done modelling of your own and it is different; gives different answers; talk about those different answers and perhaps elicit, in that way, comments from the model builders about why theirs are different from yours; or why they think theirs are better than yours.

I must say, I don't have sufficient information about the modelling to make a judgment to whether it's better than mine or not better than mine. So, I would like just to raise some questions by comparison with the ENFORUM Model developed at the University of Maryland.

These questions will be on the consumption of energy. The use of energy; whereas, those comparisons with the DRI model and with Brookhaven National Laboratory, Dale Jorgensen Associates refer to the sources of energy. That is not my area at all. I have nothing original to say about it. Though I do want to point out some discrepanices and differences that are evident in that table, and which are not very much discussed in the text, and hope that these remarks will cause those who made the model to speak to those differences between their forecasts.

Dr. Hudson may also want to draw more specific attention to those differences. Let me advertise the ENFORUM model for just a moment by saying that it is a 200 sector input-output model in which we have given the best attention we know how to the consumption of fuels by manufacturing industries. We have distinguished the major types of fuels. We distinguish gasoline, for example, from fuel oil, because these serve very different purposes in industry. We, of course, have natural gas separately; coal and electricity.

In the consumption area, the household consumer area, we have estimated consumption functions which express the possibilities of complimentarity and substitution between various types of energy or between energy and other products; so that when energy prices rise, it tends to produce energy demand.

On the other hand, complimentarity between energy prices, namely, gasoline prices and the demands for automobiles and likewise complimentarity between automobile prices and gasoline demand -- we feel on fairly firm ground in those areas.

I agreed to discuss this paper, principally, in hopes of compelling myself to read it carefully; to help evaluate my own model. We have not put into it anything like the man-hours which have been put into this model. Anyone who wants it can subscribe to it for $5000.00 a year. EIA is not a subscriber, there; though, I have many former students there and have a paternal responsibility.

(Laughter.)

To this model, I have no financial interest in it. So. let me challenge my former students with a few comparisons. The first one is no challenge. When I observed that they had done their estimation of industrial demand as one aggregate, I said, "That is hopeless." You have to be able to study the difference in the realities of aluminum production from steel production. You have to use electricity to make aluminum. How much can you save? There are certain chemical rules that determine how much electricity is needed in making aluminum. The same does not apply to making steel. You need to look at these in considerable detail.

They have not done it. Presumably, we will be very far apart in that area. However, that's exactly the area where there is no difference in the outcome.

(Laughter.)

I want to put up some numbers and I have to explain to you certain non-comparabilities between numbers which I shall then proceed to compare.

(Laughter.)

The first of those is the numbers in the report refer to the years 1977 to 1985. The numbers which I had handy and grabbed to take home with me last night referred to 1976 to 1984. So, it's the same -- it's a 12 year period, but my 12 years is one year earlier than their 12 years. I think that causes no major problem in comparison. I could certainly get '77 and '85, but they weren't in the thing which I took home with me.

Secondly, their numbers; the EIA numbers, are all in Btu. Our numbers are all in constant 1976 dollars. So, that when we aggregate over the inputs into industry, the ENFORUM numbers will be aggregated in '76 dollars. EIA numbers will be aggregated in Btu as consumed.

I might add there, that that caused me a slight problem, because it seemed to me that if there has been an increase in electricity used to replace natural gas and the electricity is being counted only in Btu of electricity, and Btu of electricity are very willing to do what you want them to do; they're used with a very high efficiency.

Natural gas with a high efficiency relative to coal, but not relative to gasoline; if industry has, because of the gas shortage, shifted from electricity -- from gas to electricity, it will appear that there has been a reduction in Btu use; but, in fact, to generate that electricity, there may have been more Btu to generate and to transmit the electricity. There may have been more Btu used than would have been involved in just the gas, which was formally used. I think that an adjustment for that could be made. It would be interesting to see the figures which carry that adjustment.

You will recall that Btu input into industry between '72 and '77 according to the EIA numbers, diminished about half a percent per year. I have wondered how much of that may be due simply to this substitution of electricity for gas. I would hope that that information might be worked out. Now, to come back to comparing the non-quite-comparable, the numbers which the C scenario has for the growth in Btu inputs into industry over the period '77 to '85; showed a 27.4 percent increase. The ENFORUM number showed a 29.7 increase -- the increase between which is altogether negligible, I would say.

When, however, we turn to the commercial area, we find that the C scenario projects a drop of 4.1 percent input. This is in line with the recent trends. However, we have also put in considerable trend adjustment. We find an 18 percent increase. Let me say that the output of these industries was growing at 22 percent more than our number. So, that the output was -- ENFORUM output of these industries was 1.408. So, we already had implicit a substantial saving of some 22 percent over this 12 years; 22 percent reduction in fuel inputs into the commercial sector.

The C forecast assumes a 45 percent reduction, at least, relative to our projections of the outputs of these; our GNP projections are not vastly different than theirs; slightly lower, in fact. So, I presume that their output projections would be, if anything, slightly higher.

PARTICIPANT: Are your classifications identical?

DR. ALMON: No. They're also not quite comparable. I can match if I had all of my numbers. I could match their classification as closely, I think, as I could learn what it is.

It's not clear to me where gasoline used in agriculture appears in their nubmers, but that's, I think, roughly speaking, the classification is not vastly different.

PARTICIPANT: I was wondering about commenting on the EIA modelling system. You're dealing with a straight SIC modelling basis. Your table corrected the modelling flows. Is that right; your projections?

DR. ALMON: It's a product base, but --

PARTICIPANT: All right. One of the problems, I think, in comparing to the EIA projection is we're dealing in billing categories, which are really not comparable to your classification of commercial. Ours tends to be a commercial billed rate. But I think that could account for some, if not all --

DR. ALMON: Okay. That's a good point; that you understood that -- that they do it by how it shows up on the billing of a utility. This has long been a problem in using utility numbers. They have this category which they call commercial, which does include some residential. It includes some industry. It is bills which are not as big as a big industry, but bigger than an individual; and it gets called commercial. That's -- I think a problem in reporting, which maybe EIA under it's information mandate might try to get the utilities to report in a way which was more comparable with the Standard Industrial Classifications used in the general statistical system. But it's a good point; I'm glad you made it. In transportation, where there is shown a 4 percent increase in the C scenario. Here, there should be no great problem about -- we show a 31 percent increase.

Well, output of the transportation industry is increasing 45 percent. So, that again, the ENFORUM numbers do reflect a substantial technical improvement. The C scenario numbers represent a super technical improvement.

In personal -- those two are our largest discrepancies. In personal consumption expenditure, where the C scenario shows 11.7 percent; we show 16.5. Again, here there arises the problem --

DR. HUDSON: You said 16?

DR. ALMON: 16; 16.5; again, the same problem of comparability from the fact that some of the apartment houses are up under commercial in the C numbers arises; whereas, our numbers are based on the definition that personal consumption expenditure in the national accounts -- and so that is against a total personal consumption expenditure of 1.356.

So we also show a substantial reduction in fuel used in GNP consumption. Total fuel, if I can find it, total; yes. Their total; C total -- I have exactly the same number there as the PCE; which makes it look suspicious.

(Laughter.)

Has somebody got a calculator that they can figure out what is the -- what is the total growth in energy according to the C forecast?

Ours is 23 versus a total increase in GNP of --

PARTICIPANT: The C would be about 1.15. That includes electricity generation.

DR. ALMON: Yes.

MR. LAWRENCE: Professor Almon, Mike Lawrence; is that transportation warehousing INFORUM or is that PCE fuels consumption?

DR. ALMON: No, no. That is transportation. It does not include any PCE. I presume their transportaion also does not include the personal automobiles.

DR. LAWRENCE: It does.

DR. ALMON: It does?

PARTICIPANT: Surprising, isn't it?

DR. ALMON: That is another major non-comparability then. I could rework that but I had not picked that up. You get that point; if their transportation includes personal consumption expenditures on gasoline, that might improve comparability. My transportation included only trucking, railroads, airlines, and in fact, theirs did not include trucks owned by firms; but only common carrier trucking, so that is presumably a narrower definition.

Nonetheless -- yes?

PARTICIPANT: What is your increase in output for residential?

DR. ALMON: That is the total growth in personal consumption expenditure. This number.

PARTICIPANT: Thank you.

DR. ALMON: Mr. Siedel?

MR. SIEDEL: Can you give us an idea of how ENFORUM handles relatively minor economic aspects, like the speed limit; like the government fraction of commercial

DR. ALMON: I am always fascinated, myself, by the very large commercial feed stocks that show up when government uses that.

PARTICIPANT: It seems to me a lot of those are non-economic. I don't know how you handle them in ENFORUM.

DR. ALMON: Well, strange to say, I didn't notice -- we didn't notice much. I guess we turned out attributing all of the reduction due to the 55 mile speed limit to price increases. I have the feeling that OPEC may have been more effective in enforcing the speed limit than the highway patrol.

(Laughter.)

PARTICIPANT: If we leave all the policy decisions to the OPEC countries, we may not need any government.

DR. ALMON: That is -- yes.

PARTICIPANT: In doing this comparison, how would you specifically handle things like appliance efficiency standards and solar technology in the commercial sector. These represent at year end, quite an offset in our projections. The number you are looking at, going from '77 to '85, there is very little growth shown over that period, because in '85, I believe, the first year shown in the report, the effects of the efficiency standards, and of the building standards in the commercial sector; also along with some solar applications from commercial too.

So, these are like demand offsets. I'm not quite sure how you're handling them in your model scheme.

DR. ALMON: They are not handled. How much of that drop do you think is attributable to solar use or to improved appliance efficiency?

PARTICIPANT: I would say, in the commercial '85, we could be talking about .3 or .4.

PARTICIPANT: Less than 10 percent.

DR. ALMON: Less than 10.

PARTICIPANT: Just under 10 percent for the commercial sector in 1990.

DR. ALMON: I know what my attitude was towards the mandated mileage improvements in the automobiles which was that if the gasoline prices went up sufficiently to make people buy the more efficient models; we would achieve them. If they didn't, we wouldn't. Once gain, OPEC seems to have come to the rescue, doesn't it? So that I have the same feeling about the appliance efficiency. If others are moved by price increases to buy those more efficient appliances, then the mandates requiring them are quite unnecessary. If they are not so moved and those appliances are more expensive, it will be rather difficult, I think, to enforce them. Of course, you can say you can't sell it unless it's so efficient, but I think that will run into a lot of problem.

PARTICIPANT: Besides the delay factor you would get by with people keeping their old air conditioners because of the price. You also will have people excluded from the market who would be buying inefficient air conditioners at a low price for special uses where they would be not used very often to cool one room.

In fact, end up using less energy because you have that inefficient air conditioner. There is an argument now going on as to whether the auto efficiency standards, if they were high enough, might not cause a delay pattern in the purchase of automobiles that would lead to a less efficient stock. I think that's a very real danger.

DR. ALMON: Let me change -- I'm running out of time -- five minutes. My boss says, though I feel I shared my time with some others --

(Laughter.)

-- I would like to use just a moment to draw attention away from ENFORUM work to the FOSSIL work represented on page 90 of part I of Volume III. The most striking number on that page is the C projection of imports at 19 quad, I guess that table is for 1990.

Now, we move from '85 to '90 to be compared with the DRI projection of 27.5 and the Pace projection of 27.6. The results of the FOSSIL projection of 21.0, but FOSSIL is another government forecasting group; whereas, DRI and Pace are independent forecasting groups.

Now that, of course, is a pretty important number; that volume of imports and; therefore, there is a fairly substantial discrepancy. The text, unfortunately, says nothing about imports except this sentence, "The uncertainty reflected in the broad range of projected coal consumption indirectly affects the petroleum consumption forecasts in the outlook for energy imports." That is, of course, the sentence that ought to be written in great big, red letters. They don't have red, but big letters. Apparently the big difference is in what is anticipated in the way of production from the domestic sources. Principally, also, in how much coal will be accepted; that this is a major uncertainty with a major impact upon the prognosis for energy imports.

Apparently, here FOSSIL and EIA part company with DRI and Pace. I hope that by my emphasis on that point, I can get some comment from EIA people, at least, about how confident they are about their differences in that respect. Thank you.

DR. ALT: Thank you.

DR. ALMON: Maybe for the official notes, I can get the numbers more comparable; get the household -- get the gasoline moved into transportation and out of personal consumption expenditure.

DR. ALT: Thank you, Professor Almon. In general, as we mentioned this morning, we would like to defer questions until all speakers have had a chance to make their comments.

Our next speaker this afternoon is Dr. Hudson, who is the Director of Dale Jorgensen Associates.

DR. HUDSON: Thank you. I would like to say, first of all, I think there is a lot of good points about the EIA forecast. Having said that --

(Laughter.)

PARTICIPANT: Can't you elaborate?

DR. HUDSON: I'd like to focus my attention on constructive suggestions about things that have occurred to me in the forecasts and the operation. I'd like to talk in three areas which I will label technical aspects of the forecast; the design of the analysis; and strategy of the forecasting procedures.

On the technical aspects, first of all, on modelling U.S. production of petroleum; I understand that the modelling that is there now focuses on new fields -- addition to reserves from new fields. I'd like to make the point that historically more than half of the additions to them come from extending old fields. There may be many reasons to suspect that with the higher prices and the knowledge that is out about existing fields, in the future, possibly even a greater percentage may come from exploiting existing fields. So, in terms of direction of modelling on the supply side, it is possible that the supply from sustaining existing fields might be somewhat underemphasized. In general, I recognize it's a very difficult problem in modelling.

I have some problems with the econometric approach, as it is applied to resource extraction, because the econometric approach assumes certain regularities and continuities and repeating of patterns from the past. I'm not sure, at all, whether that applies to geological phenomena; like the discovery of pools, et cetera.

I don't have anything to suggest in its stead, but I do think it's critical for the forecast what numbers come out for U.S. oil production. It is a very difficult area to model. I'd say there must be a very large range of uncertainty about any projection of these oil productions.

On the demand side, I wonder where the conservation and price adjustments have been incorporated in the EIA demand apparatus. There are becoming very important given the readiness of the government to move in with direct regulations and direct controls. I would say it is important from a policy and applied point of view in EIA's analysis to include specifically a lot of these non-price conservation or direct regulation types of features influencing demand.

One minor point, comparing projection C with C-Low, which appear to be identical in the assumptions through 1985. The difference between C and C-Low is oil price. The assumptions appear to be identical, but the forecasts appear to be different. I'm not quite sure if the assumptions are the same, how the forecasts can be different.

Finally, on the technical side, I would like to refer to energy/economy interactions. The projection in this report makes a lot of use of the Data Resource System, which has a lot of attractive features for short-run impact analysis. I might point out, though, that one of the key, if not the key linkages, is the variable called the WPI-05, which is the wholesale price index for energy.

Most, not all, but most interaction between energy and the economy goes between WPI-05. I happen to believe that energy interactions are somewhat more complicated than those involving WPI-05. I must say, though, that the EIA has underway steps to expand the energy/economy linkage; and I must --

PARTICIPANT: Commend us.

DR. HUDSON: Yes, right. Okay, moving on to the next area; the design of the analysis. Well, in a nutshell, this is one of the graphs which is in the report.

(See p. 9 of the ARC-78)

This demand/supply graph summarizes the design perturbations used in the report. C is the base case and there is high and low demand. Now, there are good points and bad points about this. The good points, if one compares the low supply with the high demand and the other one down here -- well, the projections to all of those fall at the corners plus the middle point, the base case. Comparing these gives you some sort of idea as to the bounds of uncertainty in the price dimension. Comparing this point with this point gives you some idea of the bounds of uncertainty in the quantity dimension. I think that is very good.

PARTICIPANT: What do you mean by "bounds"?

DR. HUDSON: I was going to come to that. For given changes in demand and supply, that map's out in two dimensions; the price and the quantity -- likely outcomes.

Now, the first issue with this is how one defines how high is that and how low is that. There's a summary table in there which gives the results in terms of the rate of growth in real energy prices; the lowest, from memory I think, is 1.7 percent per year; and the highest is 4.8.

Well, with the Ayatollah busily doubling our energy price at the moment, in hindsight anyway; possible in foresight, one might argue that the range of variation inserted in these supply sides scenarios was made a little small to capture -- well, "reasonable" whatever that might be, bounds in terms of the price and quantity outcome.

Apart from that, though, this sort of analysis involves changing all of the assumptions at once, more or less; all of the demand side assumptions; all the supply side assumptions; and it does give you some information. It gives you some sort of bounds on the prices and quantities.

There are many other applications, though, where it is useful to unbundle these and change one assumption at a time. For example, the information that you might get from this would be by varying a whole range of things; finding the effect it has on key variables; you can pinpoint which are the important variables.

With this thing you don't know what's important; you've got a dozen things changing at once; you can't separate them. So, by analyzing variable by variable, we can get a bit of a feel for the important relative to the unimportant variables. That information has been exploited for policy purposes and analytical data purposes and refining EIA's capabilities. I think there's a lot of payoff for getting that information.

PARTICIPANT: Important from the modelling point of view may not be important from the actual realistic point of view.

DR. HUDSON: How do you define "important"? I was thinking of "important" in the sense of finding some key variables. One variable I would say is key is level of petroleum imports. Okay? Then we can do variations and find what effects petroleum imports have and you find some things have small, some things have large effects.

PARTICIPANT: Sensitivity, right.

DR. HUDSON: That sort of importance. So, there's a lot of uncertainties; there's a lot of sensitivities over and above these which have been analyzed. There is one in particular, that comes to mind. It might be easy; I don't know; for EIA to do a projection with and without nuclear. I would say that has a lot of -- without EIA getting itself into the policy area, just presenting the results; letting people take it and run with it. I would say that would be topical and useful.

DR. MYLANDER: Could I interrupt and say that in the nuclear chapter; there is a discussion of the sensitivity analysis of a nuclear moratorium; because it was impossible to present the full details and because this sensitivity run is of such interest it was published in the Supplement to Volume III so that somebody could analyze it in the same detail that base case scenarios are analyzed.

We felt we were constrained by space limitations, but that question was addressed directly.

DR. HUDSON: Okay. I stand corrected. There is a nuclear analysis in there. Well, let me get down to the last area, which I will call strategy. That has a bit to do with the fact that the nuclear projection is buried on page 353 of a 1500 page report. It's a question of detailed information and what is important. Now, this is a very comprehensive detailed model, in terms of product coverage, in terms of geographical coverage. That has a lot ot advantages. The people can relate and use this detailed information.

Let me indicate some of the disadvantages that go with that. First of all, I would say that it appears to be more difficult to get good forecasts on a very detailed level, because the data is poor because even isolated events can change what is happening in coal use in New England, for example. One power station could change that. It is very risky that in forecasting it, at this very detailed level. But at the same time, there is detailed levels where people can relate to -- well, than they can relate to GNP or whatever.

So, the fact that it's risky; that there are large areas; the fact that people pay a lot of attention to these detailed forecasts means that when things go wrong, they are going to be noticed; and because of the detail, the credibility of the whole system may be thrown into some sort of confusion. Now, from an analytical point of view, you can't infer from the detail, the whole; but from the creditability public relations point of view, I think that the danger is real.

Now, there is also another effect of being a very large system, just getting the thing to run. Now, my information -- I'm not sure whether this is 100 percent right -- two, IBM 370-168's are somewhat constrained in getting the required number of runs done in the period allotted to produce the administrator's annual report. They have two big CDC systems on order to relieve this bottleneck. It makes me wonder when to --

PARTICIPANT: When are we getting them?

(Laughter.)

DR. HUDSON: When two IBM 370-168's can't give you the turnaround, it suggests the model is somewhat large.

(Laughter.)

And it is possibly somewhat unwielding.

(Laughter.)

Now, the fact that the report is about this big is fair evidence of the same thing. The fact it appears that in four or however many months allotted to produce the administrator's annual report; even these five runs that were produced are produced at the cost of great sweat, blood, toil, and tears on the part of the people at EIA.

This suggests that something is wrong. I want to go on for a minute to address what it is that is wrong. I think essentially, what is wrong is too much detail. For some applications this detail is important, it's useful, it may even be essential; but I don't think it is for all applications. There are a lot of applications, the key policy variables, are macro in nature; oil imports; the price of electricity whether there is going to be an electricity shortage; the GNP level of inflation. Things like that for many types of analysis are the key variables.

What is happening to coal in New England is not quite on the same level of importance. Now, with a small model, though it wouldn't be able to cover this information, one could argue that many of the types of information needed could be covered. Not only could they be covered; the model could be turned around quickly. You would have flexible, more responsible models. It wouldn't take you five months to do five runs; you could turn that thing around very quickly. Because of that, there would be the potential for EIA to be more relevant, if I may put it that way, in the sense of being faster to turn around information in response to a request instead of delays.

This leads me to my main point which is what information is EIA trying to produce. Now, one might think of two strategies to providing information. One of them starts with defining the information that you need. That starts before; it starts with defining your client; the type of decisions that he's making. It goes on to coming up with the information that the client needs in order to make those decisions and it goes on from there; to putting in place an analytical system that would generate that information. So, the sequence is from product to apparatus. Once you define the product, you can put in place the apparatus to deliver that product.

The other approach is to put in place an analytical system; and to make a wide, all embracing, encompassing, all-purpose model from that. From that trying to extract the information needed to address problems as they come up. The sequence in that approach is to start with the apparatus and to make it sufficiently broad; that it will generate foreseeable information needs. The sequence goes from apparatus to the information product.

So, those two approaches are different in the direction of how they are put together. Now, I might characterize the history of this system, going right back to 1974, whenever. Initially, needs for information were identified, and a model was designed to provide that information product.

Possibly what has happened since then, is the thing has been added on around the edges; layer upon layer and has gotten larger and larger on the way through; to the point now it is such a large, cumbersome system to turn around.

I wonder if the time may not be ripe to -- well, keeping this in the short run, because it is a working system and it does give useful results -- work through, again, for EIA to ask "What are their clients; what is the information product they're trying to generate?" and from that basis, to put in place a flexible, fast, responsive system that will generate the main information -- not all information, but the main information.

Well, I'll stop at that point. The main point I want to make, stemming just from the size, the coverage, and the detail of that administrator's annual report; I wonder if it's all useful. I wonder if EIA's medium-term purposes may not be better solved by thinking through, again, possibly leading to another model of who they're trying to provide what for; what information they're trying to provide, and how to set up that information.

DR. ALT: Thank you, Dr. Hudson. Our next speaker is Dr. James MacKenzie who is a Senior Staff Member for Energy for the Council of Environmental Quality.

DR. MACKENZIE: Thank you very much.

The last time I spoke on energy modeling, Iran was on the verge of going down, and I was, therefore, hesitant to come today, thinking maybe there was correlation between my giving this talk and losing a couple hundred thousand barrels a day of oil. If it happens, though, I presume there will be a great flurry of interest and legislation will probably get moved through the Hill, and we'll probably get some synthetic fuel capability out of it, and short-term problems will be addressed. But the longer-term issues will remain, and the same questions which have been asked before will be asked again: what are our needs for energy? What are our options to meet them?

It is in this context, this larger context that I would like to address the EIA's forecast as contained in Volume III, and indirectly, similar forecasts that have been made by the Department of Energy, the policy division, and others.

I speak from very limited experience, now, I agree, in the executive branch, trying to deal with the brush fires -- the embargoes, that sort of thing, and dealing with the very fast turn-arounds that Dr. Hudson has just mentioned in trying to put together some response to things like the Iranian shortfall of last winter.

The thesis that I would like to present, and this may not be the best place to do it -- is that the EIA has made a valiant attempt in doing something that is essentially impossible. And I give them "A" for effort, but I don't think the results are terribly valuable. The simple fact is that in my judgment, neither EIA nor anyone else can say what is going to happen this afternoon or next week -- certainly not 10 years from now -- and that if they did know what was going to happen, they wouldn't really have a reliable tool for putting it all together to forecast energy supply or demand.

So, in principle, neither their forecast nor anyone else's, in my judgment can be, or are, taken that seriously. And if they are, I don't know who is taking them that seriously. And if you disagree, go back a few years to all the other forecasts that have been made and what has happened to them. The Atomic Energy Commission -- remember -- thousands of reactors by the year 2000; they're down to 150. It's changed by a factor of 10. The Department of Interior was forecasting 200 quads of energy demand by 2000, and the energy industry's were similar. So, the fact is these forecasts are extremely vulnerable because of all the assumptions and vagueries of the world. And everyone is aware of it.

We've heard some of these problems being discussed this morning and this afternoon already, the limitations. In May the Department of Energy published its National Energy Plan II, and within one month, the price of oil was far beyond its band of uncertainty for the next two decades.

And they were sort of apologetic. In September they had a new range of estimates which just moved up substantially to incorporate the prices. But I think that those kinds of uncertainties simply indicate to me that the essential task of forecasting the future, in the way that is attempted through large econometric models, is simply an impossible one, and even when it is done I'm not sure how they are used, or if they are used.

Some of the reasons surrounding these problems of using the models have already been alluded to; the cost of oil is essentially being set politically now, and who knows what prices will be this afternoon or next week.

The models themselves apparently have little internal justification that others can review to see whether or not they are consistent or whether they are, in fact, solely empirically set; so they are not subject to scientific scrutiny by outsiders. They are proprietary in many cases. Most are highly aggregated with tremendous uncertainties in all kinds of non-price areas.

For example, the acceptability of technologies -- and that has already been mentioned with the nuclear power issue. Nobody knows what the administration's response will be or in fact the Congressional or popular response to the Three Mile Island accident or to a subsequent accident if one occurs. I heard one industry representative say that if another accident came close to that, that would be it; there would be no more nuclear power plants constructed. Period.

Political events, nationally and internationally -- the uncertainty is too great. If you try to encompass them all with an envelope describing the variability of all these factors, you would come out with something that is essentially useless. The range of results would be so great so that it would not be useful at all. And my conclusion is that the reason this can't be done is the future is not predetermined; it's not predictable in this sense. It is quite to the contrary. It can be guided and it can be planned, at least in general terms. I'm not advocating a centralized, planned economy, but we can consciously choose goals and directions and then try to develop policies that will get us there.

And it is this problem -- and I think Dr. Hudson began to allude to that somewhat near the end of his remarks -- that I would like to address. This is not to say that large econometric models cannot be used for policy analysis. But to expect that the total demand, for example, for energy can be forecast by these is just totally unrealistic.

They can be used, obviously, for evaluating different policy tools, for calculating tradeoffs and relative effectivenss of various economic policies for achieving a given result .

They, presumably, cannot incorporate things like regulatory efforts or information programs which may be very useful, but that no one knows how to evaluate at this point. And there is a real frustration in trying to deal with policies like that.

I would like to, therefore, propose a somewhat different orientation toward the problem of estimating energy demand and dealing with it in a way that will be useful both for the executive branch -- and I'm speaking for myself at this point; I do not mean to imply that this is administration policy in any sense. These are my own views that I am expressing now.

I would contend that we should be spending a great deal more time in our energy modeling, determining not what will happen, but what could happen; in effect, determining the envelope of possible futures with respect to both supply and demand.

And I believe -- that in so doing, we will be delineating what our national options are much much better. And we will convey a much more realistic sense that the future is not predetermined, and that we can proceed along any of several routes towards meeting our essential needs that energy now meets or provides.

This kind of work is being undertaken more and more. There are several reviews that are now being pursued -- some of these studies differ in major ways from one another. They explore physically -- and to some extent economically -- what has to happen to give you those different futures. Roger Scent at the Mellon Institute in Arlington, Virginia is making an effort to pursue this kind of analysis, as did the first Ford Foundation Study: "A Time to Choose."

I was involved in the first six month review of solar energy, and when we addressed the problem of evaluating contributions that solar energy could make, we ran some of the models.

We had MITRE run the SPURR model for us, but we didn't use it in the report to the President. Instead, we made a lot of estimates and calculations based specifically on what we thought might happen in a "business as usual" type of future, looking at the number of buildings that were going to be constructed and looking at traditional innovation rates in the building industry in the past.

And we came up with what we considered to be a base case, looking at each sector separately and then aggregating it in a very straightforward way where we could state our assumptions and change them easily. And anybody else could state them and change them as well.

And then we attempted to explore what would happen if the "national will", so to speak, were to determine that renewable resources were terribly important. We at CEQ had made a somewhat higher estimate of the solar contribution but under many different assumptions.

We came up with an estimated maximum contribution that solar could make by the year 2000, arrived at -- not using a large model -- but through plausible assumptions on price reductions and introduction rates and things of this sort. And it was a very straightforward analysis which can be reviewed by anybody.

And then we constructed what we called the "technical limits" case, which was almost an industrial war footing, assuming that the government really had the authority or assumed the authority to do almost anything.

And it turns out that contribution wasn't as large as we thought either. I consider that to be, as limited as it is, a useful tool because then we had the sense of what had to happen.

And I don't get that kind of understanding from the large models; they are driven by you, the experts. They are driven by a lot of economic assumptions, but they cannot incorporate all the types of things that are occurring in the non-economic realm.

So the calculations that I would propose ought to be done are those that focus on what can happen: what can happen in transportation demand if we were to make a serious effort to move freight by trains instead of trucks; if the Building Energy Performance Standards are adopted so that new buildings in fact do meet the prescribed levels that the code will set; that assuming a large but feasible rate of retrofitting of buildings occurs, what would be the building demand, and so on. We will then get a better sense of the total demand for energy under this range of possible national policies.

The reason I believe this kind of forecasting is so terribly important is that with the publication of the Harvard Business School report and several others, the frustration in the Congress and certainly in the administration has gotten very large. People now are aware that we are not nearly as efficient with energy as we could be, given today's prices, and there is a recognition that there are very large institutional barriers which are frequently non-economic, the landlord-tenant problem being the most notable one, where 35 percent of our dwelling units are rented and economic incentives just don't work very well. In this instance, neither landlords nor tenants have any particular inventive to make any capital investments, and this is so largely in the commercial sector as well where accountability does not occur with the consumer.

And as a result, the price incentive that one might think should be there is certainly frustrated by these institutional barriers. And everybody that I'm aware of in the executive wants to do something about it, from the President on down; and the same is true in the Congress.

But they don't know what to do; they really don't. They don't know which policy to try and push, whether it's economic incentives and they don't know what the effects will be: tax credits, conservation banks, regulatory approaches. They're all being discussed. And there's a great uncertainty because of the lack of understanding of what the consequences of these policies will be on actual end use.

So my feeling is that we should understand much better, in a strategic sense, our energy options: a high growth future and what that implies to the extent that we can understand it in terms of national security implications, in terms of environmental impacts, and employment, and so forth; and to the extent that we can understand them, the low growth futures, which would put a large premium on consumer education or whatever else it takes to influence consumers to use energy in an economically efficient way.

And more than that, we need to understand what I would call, really, the far-term implications of these futures. Certainly, there are some estimates on the world's recoverable oil reserves, and the forecast that the government produces ought to be able to be extended right through the peaking period of world supply to make sure that it makes sense and that we're not still on a rising curve of imports long after world supply has begun to decline. Similarly, we should try to recognize things like the carbon dioxide problem, and if that should present serious problems three or four decades from now, that should surely be part of that analysis of strategic energy options that we have before us.

In addition to this kind of strategic analysis of the various futures and the aggregate effects of what they imply, I think a lot of micro-analysis should be done, and it's certainly not being done in any systematic way. And that's again where I think Dr. Hudson's model, a somewhat flexible model, where various policy options can be reviewed on fast turn-around, would be extremely helpful.

But we probably need a much more thorough review of the various factors affecting energy use; not just economic, but the non-economic ones as well. I think they are far more important, and you as consumers, I'm sure, appreciate this problem. For example in insulating your home, whom do you turn to and what is the payback? A neighbor asked me over the other day. He had just gotten a PEPCO audit, and asked: "What should he do?" We went up to the attic and found all kinds of places where for $10, he could plug up holes that went directly down into their utility room; around the heating shaft there was a three-inch annulus.

And my guess was that for $20 and a little bit of information -- sophisticated house doctor audit as people are talking about it now -- they probably could save 10 or 15 percent of their average use. It's not that economically people are not motivated to do it; they just don't know whom to turn to and they don't have the information to do it.

So the various policy options have to be better analyzed in a more systematic way than we are able to do it now.

My final observation, then, is that I don't really see the utility of doing these long-term, three or four or five decade econometric runs, when the uncertainties and the parameters are so great as to just overwhelm them. I think what we need is an understanding of the futures that are available to us: In other words, our strategic options, the cumulative implications for each sector of importance and an analysis of some of the policies, in a microeconomic sense, that would help us achieve our goals once we establish them.

And with that, I will stop.

DR. ALT: Thank you, Dr. MacKenzie.

We would now like to open the floor up to questions and/or responses from the audience.

DR. TAKAYAMA: I have a layman's concern, as a layman I share the concerns about the large-scale modeling and the usefulness of it.

But let me try to emphasize some of the aspects of the large-scale models that may benefit you tremendously.

EIA has a model which, as you can see, is a tremendously large model. According to Ed, we do not run the computer -- or computers efficiently? As a matter of fact, some of the OPEC large-scale models really smoked and almost burned the European computers.

We haven't been, I guess, that careless: I just represent my own responsibility in the demand areas. We have four sector models; a residential sector model, a commercial sector model, and now we are bringing in transportation and industrial sectors.

Now, obviously, some of you have introduced separately developed sector models. You have something to say as well.

In the case of residential and commerical models, the Office of Technology Assessment (OTA) has been using the EIA model and producing residential work on the basis of the first residential model.

The standard models can be used very effectively. We have them in house. That's our model; we developed it; OTA found it useful and used it.

Commercial models have been used similarly. But for the transportation and industrial sectors, I have a great concern about doing so.

What would be the total effect of individual models running individually without any thought of constraint? That would come from the supply side, I guess. So here comes the interaction of supply and demand, which is awfully important in this case.

Now, there may be a better way to do that, and Ed and Dale are running their own general equilibrium model. And I have great respect for them in pursuing difficult tasks in a slow moving, problem solving, simulator sense.

Did I criticize you? I guess not.

(Laughter.)

Now, coming to the total modeling framework, if individual models are used everywhere, when it comes to the evaluation of the total effect, that is where the integrative effort is needed. If the supply constraint is severe, then demand has to give, to raise prices or regulate consumption or some such thing.

If there is any kind of strategy that really is important in the policy area, it's got to be conservation and we have that kind of component. So that's why residential conservation reports and such things can be based on the stand-alone models that we use.

But looking into the future -- you referred to the (ONAES studies), and although I read these studies several times -- I still am befuddled and I'm awfully hazy about some of the modeling strategies that they use.

Is there any clean model large enough but effective for your purposes, the President's purposes, or Congressional purposes -- a model that encompasses an economy-wide analysis of policies.

I guess you've got to go to a detailed model that is credible.

In some sense, Ed said that credibility has to be obtained by doing some critical work, understanding what the needs are for this kind of modeling.

That is quite clear, but we had the need at the beginning, although maybe now we are generating interest, generating customers, clientele by working our own solutions.

Well, I am not sure we have been successful, but as is common to most of these large scale models, we have to struggle to get customers. OPEC's models -- our subcontractors -- they are all struggling to get their credibility established by getting these models run.

I think there is a tradeoff between getting models run and getting more credible results, Jim; I'm not sure where I should stop, Ed, and where you should stop.

(Laughter.)

DR. ALT: Jim or Ed, would you like to respond to that?

DR. HUDSON: I'm not going to respond to that; I'm going to criticize Jim also. I'd like to say that although it is dangerous to do long-term forecasting, we've got to do long-term forecasting; it is as simple as that. The reason is because even in the period out to 20, 25 -- whatever -- we've got to forecast because decisions are being made that affect that period and decisions have to be made now in order to have supply capabilities, or whatever, in place. So there is risk in long-term forecasting, but I think it is essential, unavoidable, imperative, and you've got to do it.

DR. ALT: Thank you. Dr. Mylander?

DR. MYLANDER: I want to address some comments to all of the speakers; I won't take much time. But just the requirement to do forecasting, EIA has no choice. We're under a legal mandate to do forecasting for short-term, midterm, and long-term.

And we're also under the legal mandate that we will not be setting goals for the nation and not doing forecasting to advocate policy.

So we do not have the liberties that Jim MacKenzie has when he works at CEQ to set the kinds of goals that he believes are reasonable.

We can evaluate other people's goals when the Congress or executive branch makes a request of us to evaluate whether a policy would achieve impacts that other people say it would. We can then offer our opinion. Briefly, Dr. Almon asked the question: what's the difference between the forecasts reported on page 90 of the annual report, DRI, Pace FOSSIL, and EIA forecasts?

If you look at those forecasts, the total Btu consumed in the nation are very similar for a good reason: they all spring off the DRI forecast. So they are not as independent as they look.

The DRI macroforecast feeds them all. FOSSIL and EIA forecasts are not that greatly different because the FOSSIL model has been calibrated to the MEFS model. It's viewed as simple, fast reacting model to serve the purposes that Ed Hudson was describing, for doing quick reaction policy studies.

FOSSIL has been calibrated to our model, so you wouldn't expect them to be greatly different. But they did take liberties where they thought we were wrong.

The models do differ on the supply side because of differences about the way they project supply, which then results in different projections of imports.

I think George Lady in his remarks this morning hit upon one of the key differences: we project under current legislation.

I believe both the Pace and DRI models project under what they believe is going to be the legislative environment to exist in the future. And that impacts on both coal and oil production, probably in a negative way; it decreases the forecasts.

DR. ALMON: Can you elaborate on that point?

DR. MYLANDER: One example is that our coal forecasts are driven by electric utilities buying up the coal and retiring oil and gas fired generating plants on an economic basis and replacing them with coal plants, when they have the sufficient time to build a coal plant to replace them. Given that, it looks like our forecasted coal prices justify the higher capital costs for the coal plant. It's a very high capital cost when you figure the coal plant is to replace oil and gas plant with its suck cost.

That is, we have a behavioral assumption built into our modelling process that we didn't fully appreciate when we started writing up these forecasts. We only came to a full appreciation as we saw these differences, and that is the assumption that when it was in the consumer's interest to replace an existing oil-fired plant or coal-fired plant, utilities would do so.

There are a lot of constraints that probably prevent this type of behavior by utilities; public utility commissions don't much go for stopping the use of oil-fired plant and keeping it in the rate base, and replace it with new generating capacity. When you bring in that new generating capacity, in the short term you're going to drive prices up even though on a life-cycle cost basis it makes sense.

But we have a problem there and the way we model capital investment decision making in our midterm forecast. What we're going to do about this problem is not clear.

Ed brought out the question: to what extend do we include non-price adjustments that influence our demand. I'd like to leave that one to Tom or Jerry to discuss.

Then he brought up the difference between our C and C-low forecasts in 1985 with exactly the same assumptions. And they are exactly the same assumptions, yet those forecasts differ.

Part of the difference can be explained in the fact that we do assume some foresight in our forecasts. So the C scenario sees oil prices increasing in the late eighties. The C-low scenario sees oil prices remaining constant.

One of the differences -- not so nice to bring out in public -- and that is there is an instability in our modeling process. We're bringing together many components in only a semi-automated fashion that causes some differences between forecasts, depending on what order certain submodels are run and calibrated and information is fed back and forth amongst submodels.

I'll show how bad that story can get, because we have explored it and related it in the report. We have what we call the C* (C-star) forecast for 1985, which was made after the C-low and the C forecast; the total energy demand in that forecast is 89.6. The C forecast for '85 is 89.5, and the C-low is 90.2.

So some of the difference is explained by just the order in which we ran the submodels. The two forecasts were run closely together show a difference of 0.1 quads.

Ed suggested we need to do more sensitivity analysis, and I would like to say that if anybody would ever have the time to read that whole report, we do present a lot of sensivity analysis, but it's in the chapters that disucss that issue specifically.

There are sensitivity analyses about assumptions on oil supplies in the oil supply chapter. There are sensitivity analyses about the behavior of electric utilities in the electric utility chapter. And this goes through every chapter in that report.

Now, one final comment about computers: we do not use two 168's all the time to do our forecasts. We only would like to.

When we get a free reign, which we used to get before EIA fully loaded its computers with other users, in our peak load period we might have used one 168; on the average, we were using about a quarter of one 168. Our usage has now gone down and we don't get the peak-time we need anymore. So we cannot go up to use a 168 for a couple of weeks at a time anymore. So that is one of our problems.

We do have a contractor; Stanford is working on this problem of trying to develop an alternate midterm forecasting modeling system for us to be much more responsive. And it would serve the need for a quick turn-around, a national level model to address those kinds of issues.

DR. KNAPP: When you're talking about differences in results when supposedly the same assumptions going into the scenarios; you're not saying there's multiple equilibrium. You're saying the same assumptions produce different results if you order the submodels in a different order.

DR. MYLANDER: Okay. I wasn't talking about multiple equilibrium. We do have a problem in multiple equilibrium which is caused by instabilities in the gas market caused by the Natural Gas Policy Act, which I believe might be instabilities in the real world, too.

DR. ALT: I believe one of our panel would like to address Dr. Mylander.

DR. MACKENZIE: I'm delighted to see that I stimulated all this discussion, but I look at the problems that are posed by these models; I'm sure they're the best we can do.

But I look at the long-term one, the forecast for 2020, and it says 169 quads, almost 4 billion tons a year of coal. We mine 600 million tons.

DR. MYLANDER: It's 700 now.

DR. MACKENZIE: 700. We have -- my calculation indicates about 1000 nuclear power plants, and, you know, it's still rising. Demand is still going up. I think that that is an unreal world. I think that when a calculation is finished you have to sit down and apply a judgment of reasonableness. I mean, we all do that: did it come out right?

We all do that. We do that anyhow. And if you know that intuitively, it doesn't make sense, you begin to wonder what has gone wrong; that if this thing keeps showing demands going up like this, you know: are we just going to mine 4 billion tons of coal?--or God knows what it produces -- for 2050.

I think it's time to reassess tomorrow, and that is perhaps an extreme example. But for 2000 it shows 250 gigawatts of nuclear, as far as I can see, which is perhaps 100 more than anybody is thinking about, as far as I can see. People are still canceling nuclear plants. We're going to be lucky to have 150.

The point was raised on oil and utilities. The President in July announced a program to try and back out half of the oil that utilities now use by 1990. And he's got a $5 to $10 billion grant program and all kinds of things to try and get that done.

And I recognize the problems that poses for you. And I'm sure we can multiply those problems because there are going to be more energy messages like that which you cannot possibly take into account at this point.

But, I guess I would just stress criterion of whether or not in the long term this makes sense -- someplace it breaks down; I don't know where it is.

DR. ALT: Thank you, Jim. I believe there were several other questions or responses.

PARTICIPANT: I just wanted to make one additional response. I wanted to say a couple of other things on the turn-around issue: I think that one of the advantages of having a detailed model available is that when a policy comes up, the structures there address the policy, and most of the time we aren't tying up the computer on production work.

But our time is spent modifying the model to enhance it for another policy, and to go to a less detailed model, it would give us a smaller capability and make it much more analyst time-intensive every time that a policy issue came up. So I don't think that the solution is incorrect.

DR. ALT: I believe our speakers have already addressed the need for models for policy evaluation.

Question?

PARTICIPANT: I take some umbrage to the comment that our forecasts aren't taken seriously. There's a great deal of foresight in the supply calculations because there is a great deal of economic momentum in the system. No matter what we do tomorrow, we are going to have probably in the range of 95 to 110 gigawatts of nuclear capacity in 1985.

Similarly, for the demand side.

I'd like to point out the comment to be made here is, yes, there is uncertainty in modeling. But we have the foresight and we have economic momentum working for us to probably the 1990 timeframe.

And then I think beyond that time period there is a greater uncertainty attached to everything we do. Thus, we have a broad range of responses in the supply and demand calculations.

And as far as taking forecasts seriously, we can say personally that people come to us and say: "What is your best viewpoint on this?"

So people do take us seriously, and we do our best job. I think the same follows for all the other supply and demand calculations. We don't like to be treated too lightly and I don't think we are treated so lightly.

DR. MACKENZIE: I would like to know why there are no forecasts for the year 2000 under 100 quads when it strikes me that the micro-analysis indicates that we could be doing with 30 or 40 percent less energy than we have now and enjoy the same lifestyles, the same end uses. And it's economically attractive. Why is it that nothing less that 100 quads comes out of the model. Does anyone have an answer?

PARTICIPANT: Because it isn't economically attractive.

DR. MACKENZIE: I think that's not true. I think there is a lot of work that has been done that does show that conservation measures have high first costs associated with them and there are problems with finding the money to do that. But I just don't think that is the answer. I think the model is incapable of doing it. It would be tied in with the GNP, and so forth.

DR. TAKAYAMA: Jim, is it the structure of the economy or the model that allows you to produce certain numbers that other models cannot without going through a tremendously drastic overhauling of the model structure and the accompanying economic logic?

If that is the case, what sin do you have to commit in calibrating your model to get the numbers you want?

DR. MACKENZIE: I just think the model is not capable of answering all the questions we would like to ask.

DR. TAKAYAMA: That's for sure; no model is complete, Jim.

DR. MACKENZIE: My view is it leaves out a certain number of important possibilities.

DR. TAKAYAMA: I understand your views, yes.

PARTICIPANT: Dr. Mackenzie, you keep bringing up the demand studies as an example of what we should be testing for, meeting demand. The fact is their low energy future had energy prices rising by a factor of four and we don't have energy prices rising by a factor of four.

DR. MACKENZIE: First of all, they had the advantage of looking at different futures and trying to assess the differences between them. Now, price is one way of reducing demand.

As you know, regulation, for all its problems, is another way, and that's the road we appear to be taking in transportation and building because the market just doesn't work so well in some of these areas.

So price, I guess, is the easy way of simulating a lot of the policy options from regulation to education. So there are lots of ways of achieving the goal; I don't mean to imply that prices have to -- although at the rate we are going

DR. TAKAYAMA: It's stated clearly that we do not know how to get these lifestyle changes implemented.

Okay?

DR. MACKENZIE: Nor does anybody else. I don't mean to imply that anybody does. What I am saying is that it would be nice to understand what else is <u>possible</u>. And I just cannot imagine it coming out of an econometric model. I think auxiliary or ancillary calculations --

DR. TAKAYAMA: All the processes have all the engineering common sense in it.

DR. MACKENZIE: I agree.

DR. ALT: The gentleman in the white shirt.

PARTICIPANT: I was just going to suggest that possibly these economic models are more concerned with the economic desirability of producers than consumers. Producers like to grow.

DR. ALT: Any comment?

PARTICIPANT: I'm an engineer, so I have no idea; maybe an economist could tell me. I'd like to save also.

DR. KNAPP: There is nothing explicitly in the models that I know of that would represent that. I think Charles would agree.

DR. MYLANDER: The GNP.

DR. KNAPP: The consumers are responding to that in the same way industry is responding to it with slightly different coefficients. I don't see any inherent bias. There may be one in attitudes about the way model results are used, but the model was set up to be an objective tool, and I think it has been an objective tool, you know, from that standpoint.

DR. ALT: Did you have another comment?

DR. KNAPP: Yes. When we were talking about the consumption under 100 quads in the year 2000, it occurred to me that that may point out one of the important features of a large scale model in that it enforces accounting rules and enforces consistency on the way you do things so you don't double count.

I can get a forecast under 100 quads in 2000 easily by adding up a set of conservation savings. But I predict there is a lot of double accounting in that.

They don't allow you to save the same Btu twice. I think that's an important feature of it, just the accounting rules conventions. And that is the right way to look at it. It's a lot of people's knowledge going into a computer tool which enforces consistency on the inputs and which keeps it from making inconsistent decisions.

And so maybe you don't like the forecast, but you have some security that that forecast is consistent, given the model structure.

DR. ALT: Thank you.

Question?

PARTICIPANT: It is my impression that we have two problems: one is data problems, the data they used. Another problem is the mechanics they use for building the models.

My question is whether EIA has compared all its major models on the data sources and also on the mechanics of the models.

DR. ALT: Who would be qualified? Charles, George, has EIA compared its models?

DR. TAKAYAMA: Tom Mooney can answer for the data, and --

PARTICIPANT: There are certain data inconsistencies when you go between models; almost every model has its own data base. I would like to see two-digit SIC classifications along with some end use detail.

But this is not as simple as what it appears to be because this information would have to go through the system, and it's going to have to get approved, and utilities are going to have to supply it.

And so when we're talking about a change like this, you know, you're talking about a change that would take possibly one or two years.

The other problem, I think -- I know that when I prepared some of the data base, in the year '77, we had around .2 difference -- .2 quad difference in natural gas use. And I couldn't understand this, and I still can't. But sometimes the surveys are collected at different points. I think one of the goals of EIA I would like to see eventually would be to establish a uniform data base so it could be used by anyone who is interested in building energy models.

And the other point which I was raising my hand about was when Jim said -- he made a comment which I don't fully agree with -- that it appears to be in the United States that we're taking the same path of legislation to enforce efficiency. I'm not quite sure whether this is true or not because the average consumer in the United States has never seen energy prices that confronts the consumer in Europe. There are two reasons for this: one, we've always had supplies very close, so historically we've had very low energy prices. Also, in Europe -- the taxes that the United States puts on most forms of energy -- we take a look at it in terms of excise tax and use tax -- in Europe they are also a general revenue source.

And for us to really have pricing be the sole mechanism, there would have to be a conscious decision made to change the way we raise revenues in this country.

DR. ALT: Thank you.

As moderator, I would like to take a few minutes. There was a person who did submit questions to Dr. Lady. They are anonymous, so beware.

(Laughter.)

The first question is: to what extent have past reports been accurately predictive?

(Laughter.)

DR. LADY: You're asking me?

(Laughter.)

DR. LADY: We don't have a good answer to that because most of the projections are for a time period that haven't happened yet.

DR. ALT: Okay.

(Laughter.)

The second question is: to what extent have past reports been self-confirming by their very existence?

DR. LADY: I don't know the answer to that question. Why would the report cause the future to be as it said it would?

DR. ALT: Yes. To what extent have past reports been self-confirming.

DR. MYLANDER: I know to one small extent that they are self-fulfilling, but I hope they're not self-fulfilling in their oil price projections.

But in making our coal projections we assumed that there would be adequate leasing of federal lands for coal mining in the west.

DOE's coal leasing office in the coal area uses our forecast to decide what adequate lands they have to lease. So it is self-fulfilling to some degree in that one area. That is the only area I know that they are self-fulfilling.

DR. ALT: Thank you. Are there any more questions from the audience?

PARTICIPANT: No.

DR. LADY: There was something that was brought up that I can respond to, and I will because I think it's interesting; which is problems associated with using large models, and I'm not sure that our model is uniquely large, but it is very large.

As was pointed out, whether it takes one or two computers, it does take a lot of computing, and generally speaking it is a problem.

As a matter of fact, you might note that the Secretary of Energy asked a management consulting firm to study the practices in the entire department, and the only thing they could think of to say about EIA -- the only thing had to do with the fact that the analysis process depended on large, essentially cumbersome, quasi-mysterious, so-called models.

So we are responding to this, and I will tell you very quickly what we are doing: We are going at it on several fronts, and it's all common sense.

First, there was the idea which was discussed on making the models less detailed in some sense, perhaps more tailored toward specific issues. We are not really very enthusiastic about this because the questions don't tend to follow the ambition of simplifying the models.

On the other hand, we could just make them run faster in the computing sense, and the organization at Stanford is currently helping us with this.

I don't know if Charles has heard about some of the things they do, but there is a chance that we can make it run faster on the order of two orders of magnitude. That is pretty good.

The reason I came up to the podium is actually from the standpoint of an intellectual problem, we are attempting things which I think are extremely interesting, and I bring them to your attention because you might watch and see what we do.

Actually, the problem is not anything more complicated than understanding -- the problem with large models is you can't understand what you get out of them very easily. You have hundreds of thousands of variables and anything that you do that causes you to run it again takes a long time -- the problem is you just don't know what you have.

As a result, we are beginning to have a growing and successful program in computer assisted analysis of large models. And there are all sorts of disciplines which we have identified in academics which leads me to believe that this will work. There are implications about dealing with the information that come up. There are issues of decomposition and structural characteristics of the model so you can tell in advance what will happen.

All of this can be dealt with in a rigorous way, and we are going to try to. And I think in the end that will be the proper response.

I would guess that in terms of the academic community, if we are right, this will become a field where there is not a field now. I think this problem is not just dollars. It is generic to the computing machine. And it's something starting now.

DR. ALT: Would any of our speakers like to make any other comments?

(no response)

I thank our speakers -- one more quick question.

PARTICIPANT: I don't know how quick it is: a question for the modelers in general, and that is the difference between a real rise in the domestic energy price and the real rise in foreign energy price. As foreign prices rise, there's a drain on the real value of the domestic economy, and I'm wondering how it's handled in the current system.

DR. ALT: Would anybody care to comment?

DR. ALMON: In which systems?

DR. TAKAYAMA: Good question.

PARTICIPANT: In either system.

DR. ALMON: At ENFORUM it's very simple; we have control over the two prices separately. We have the foreign price. If the domestic price is then regulated at something different from the foreign price, we hold it there or we can tie it to the WPI or do almost anything with it.

And then the mix of the two, according to the component, the weight of the two, feeds in to the price of the refined product, which then influences the use.

Or we can say the domestic price will move up with the imported price. So we have either possibility.

PARTICIPANT: How do you handle the effect of the large payment for the imported oil?

DR. ALMON: That makes Americans poor.

(Laughter.)

DR. TAKAYAMA: With respect to GNP?

DR. ALMON: Yes. It means that in order to maintain the same balance of payments --

DR. TAKAYAMA: You have to export more.

DR. ALT: We can have one quick response.

PARTICIPANT: One way to answer that question might be to bring the effects of the macroeconomy in the DRI macromodel, which is used as the macroeconomic representation for the energy forecast; there is a foreign sector included which does explicitly account for the industrial activity in the country which constitutes our major foreign trading partners. This feeds into the foreign sector of the model and affects the balance of payments and the exchange rate, which then get caught up in the whole simultaneous process of the model and ultimately affect the macro results.

I guess I'm somewhat glad that that question came up because I've been debating whether to make a comment regarding something that was brought up by one of the speakers, and that was with respect to the economy-energy interactions that are involved with only one variable in the macromodel that is used to drive the EIA energy forecasts.

And to avoid any misrepresentation on the record, I would just like to indicate that for people who know the DRI macromodel, they know that is not the case; and for people who don't know it, I can give a few examples as to how energy is embodied in the economy quite carefully, and including the representation of capital, labor, and energy in the equation for GNP. It enters the foreign sector in the exchange rate and consumer demand. Also, the WPI-05, we put in nearly two years ago now and have a disaggregation of each of the prices that were and did represent WPI-05 in that case.

So there is some kind of a representation in the macroeconomy as well as the international work that the EIA people do themselves that underlie these forecasts.

DR. ALT: Okay. Thank you very much. I thank our speakers and I thank our audience.

Now, we would like to take a brief break until 3:15, and then we would like to continue with long-range forecasts.

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CHAPTER 5

LONG-TERM ENERGY SUPPLY AND DEMAND

SPEAKERS:

Dr. John D. Pearson, Energy Information Administration
Dr. Kenneth Hoffman, Math-tech, Inc.
Dr. David Knapp, Chase Manhattan Bank
Dr. Russell Thompson, Research for Growth and Transfer, Inc.

DR. ALT: Welcome back! We would like to start the final session for the first day of the symposium. This session is a natural continuation of previous sessions.

First we addressed short-term energy supply and demand and then mid-term energy supply and demand.

Now, it is only proper that we turn our attention to the long-term energy supply and demand.

As the EIA representative, we have Dr. John Pearson, who is Director of the Division for Long Range Analysis.

DR. PEARSON: I thank everybody for sticking it out to the long term. I am honored that I am getting more than five minutes like short term.

Since I've got about 15 minutes, I would like to give you a one hour talk on how our model works. Then I'd like to give you, perhaps, a 30 minute briefing on the key results. Then we might follow it up with a 30 minute analysis--or perhaps discussion of what the other people are going to say.

(See Exhibit 5.1)

First of all, LEAP (the model we used) makes long-term projections over the time interval 1975 to the year 2020. The year 2000 is the first year we start.

The representation of the long term is via the LEAP model. I'm going to try to give you a quick summary of its characteristics.

The principal one is that it is a non-LP type of methodology. This is our contribution to the idea that we should try something else besides conventional LP. We decided to try the SRI-Gulf methodology because we

LONG-TERM ENERGY SUPPLY AND DEMAND

- Projections made for all fuels 1975 - 2020.
- Representation of the long-term is via the LEAP model.
    - quick summary of its characteristics:
        - non LP methodology
        - an alternative approach to modeling
        - important attributes for technological penetration.
- Supply and Demand assumptions.

EXHIBIT 5.1

noticed that some of our competitors seemed to do pretty well with the SRI-Gulf model that doesn't use LP at all.

Thus LEAP is an alternative approach to modeling. The modeling technique has two principal attributes. The first one is that it is heavily structural. There are very few econometric components in it, although many of the estimates will ultimately be derived by econometric analysis.

The second attribute is that it studies probable technological penetration in some detail and allows one to draw in parameters which seem to be key to the idea of what technological penetration is actually about as I will discuss.

Now, having taken a quick, informal census around here, I discovered that very few people have read Chapter 5, and indeed very few people know how the model works. So I will also try to summarize what is in Chapter 5 at the same time.

Now, let's look very quickly at what LEAP is. (I forget what "LEAP" stands for, but it's not important at this stage.)

(Laughter.)

Primarily, it is a simulation style of approach. But it's distinguished from most simulations by the fact that it does a pseudo optimization at the same time.

Most simulations simply march forward from year to year. The only information they have is the current year and perhaps one year in the past. In making decisions, LEAP marches forward but, in addition, LEAP looks forward to the end of the 50 year time horizon. It has perfect foresight, an attribute which is important to understand in the reviewing solutions. It assumes that planners look forward, that they do have foresight.

A second part of the simulation aspect is the fact that it is a modular approach. Basically, we assume that the energy system is a network, supplies to demands, and the decisions that are made at various stages in this network fall into four basic categories. The principal one is energy conversion, e.g., oil to make electricity, coal to make synthetics, etc.

The second component is market penetration. If you have two kinds of technologies competing for the same market, the concept of market penetration has to be substituted to study how one takes over the market.

The third component is that of depletable resources. Oil and gas will be depleted and clearly this is going to have an effect that has to be modeled.

Now, perhaps it's easiest if I go straight to an overview of what the current LEAP structure was when we did the forecast last year.

Basically, the LEAP network represented a 10 sector model.

(See Figure 5.1)

The four right hand sectors represent demand sectors: residential, commercial, transportation, and industry.

The top left hand sector represents utilities, drawn up on the demand side. In the middle is the distribution and on the bottom the supply sectors. An import sector has been rather hopefully assigned within the supply sectors.

Uranium, coal, synthetics, oil, and gas go on the left hand side. And, here transactions (flows through the network) are represented.

What I'm going to do is just to show you a few choice sectors among the ten, which illustrate the kinds of assumptions that were made.

LEAP NETWORK

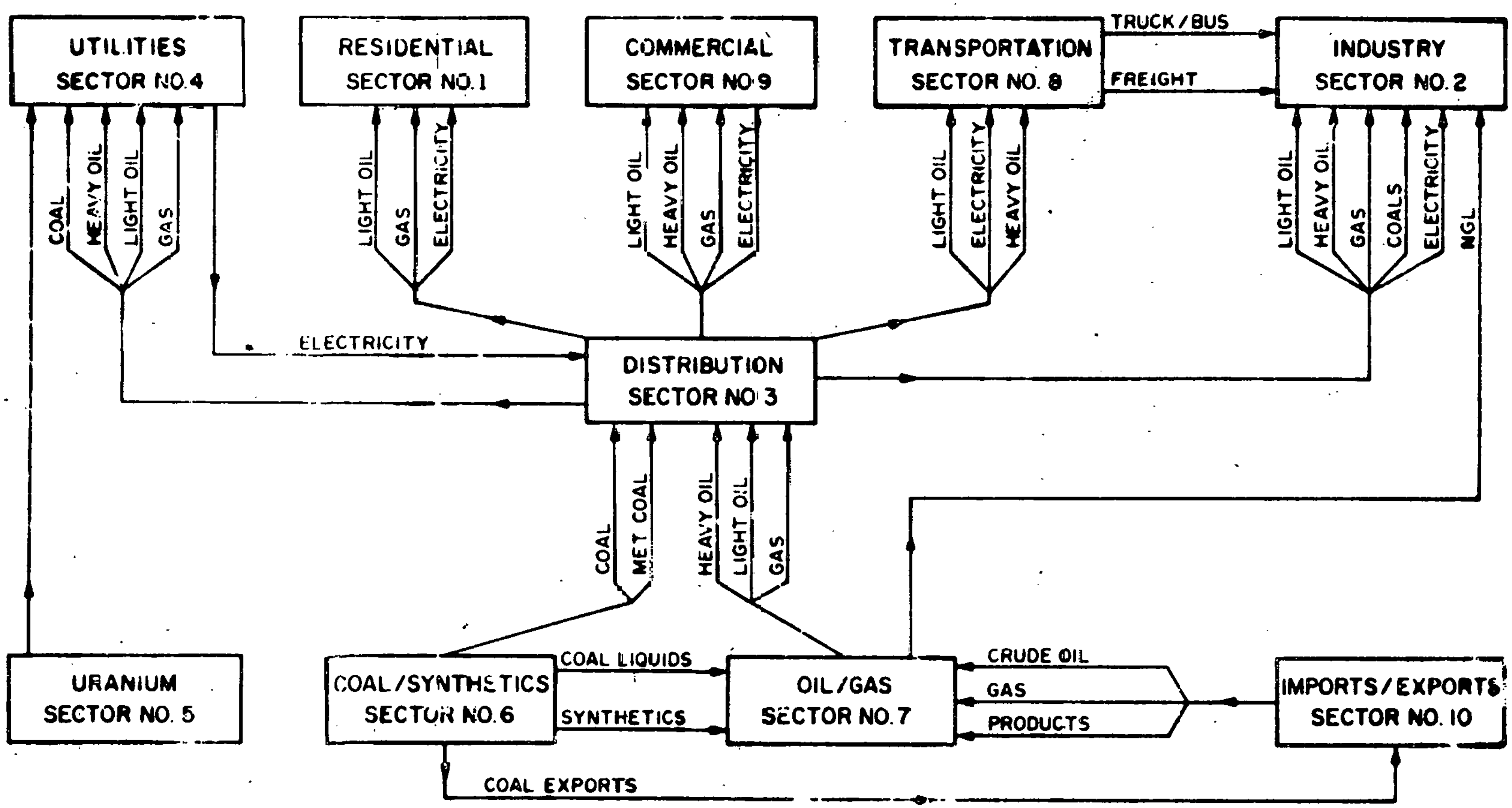


Figure 5.1

First of all, I'm going to start off at the industrial demand level.

(See Figure 5.2)

Basically, we assumed that industrial demand is driven by the rate of growth of the economy.

Industrial demand drives, what we call, service demands. These are demands for items like direct heat or indirect heat, electrolytic services, trucking, etc.

The way it is modeled in the structural sense is that, going down any one of these paths, service demand is delivered by a choice of competing ways of getting it. For example, if we want process heat, we have to find different ways of generating it.

These consume fuels. The fuels come from a distribution sector.

For example, for indirect heat, the various arrows represent the seven different ways of generating indirect heat from the various processes: indirect heat from gas, from oil, from solar, from coal, from AFB, and so on.

Each of these boxes represents the kinds of decisions that the industrial sector has to make when it decides to generate heat using that particular fuel and that particular technology, to spend the capital to pay the taxes, to pay the interest, and to retire the debt.

Let me flip very quickly through these.

(See Figure 5.3)

I told you that the fuels are aggregated and come from the distribution sector. Let's go on down the network.

Here is the electrical sector. This shows the different ways we used to generate electricity in the ARC-78, ranging from conventional light-water nuclear reactors to things like hydro, renewables, biomass, gas turbine, and so on.

INDUSTRIAL SECTOR (NO. 2)

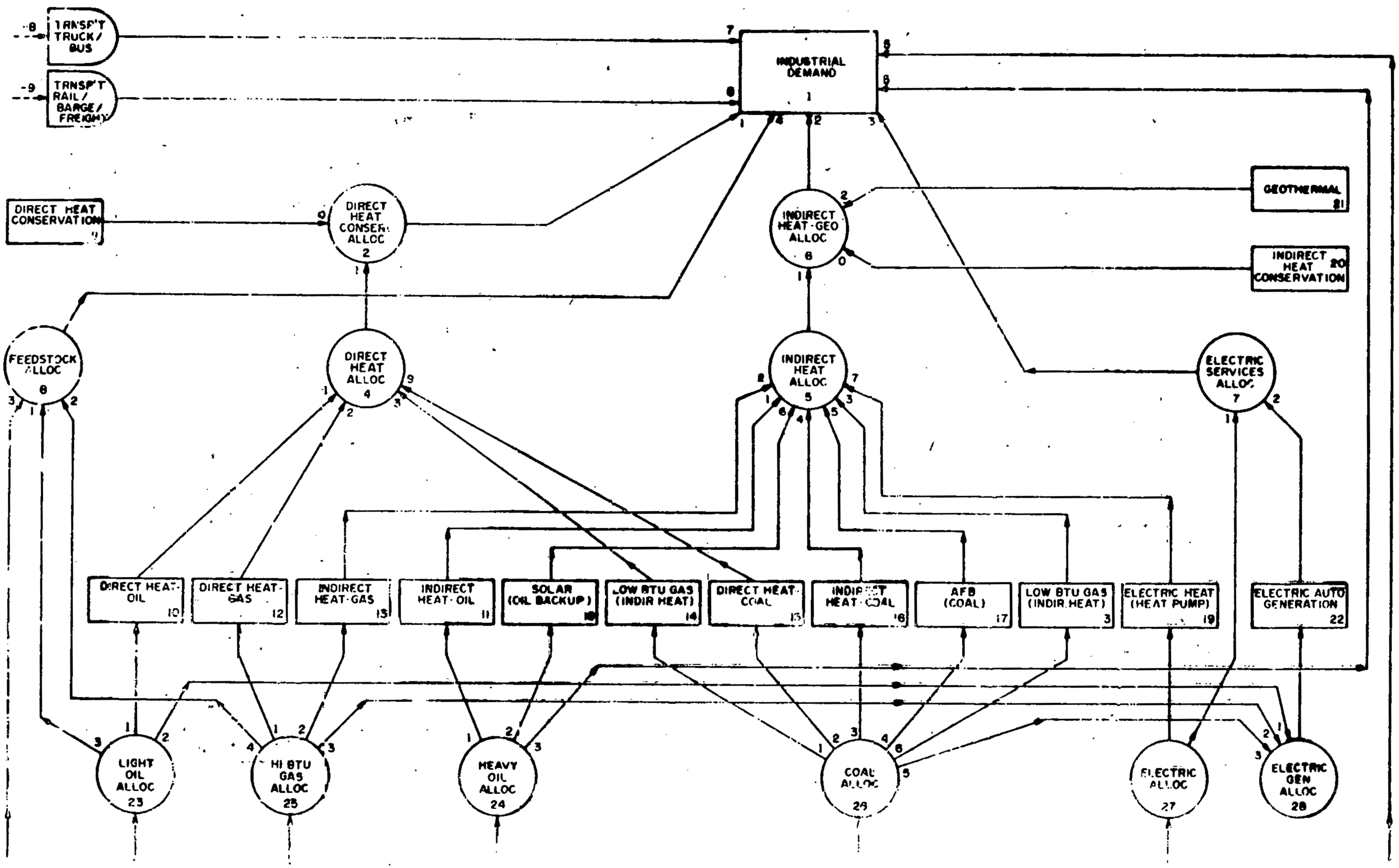


Figure 5.2

ELECTRICITY SECTOR (NO. 4)

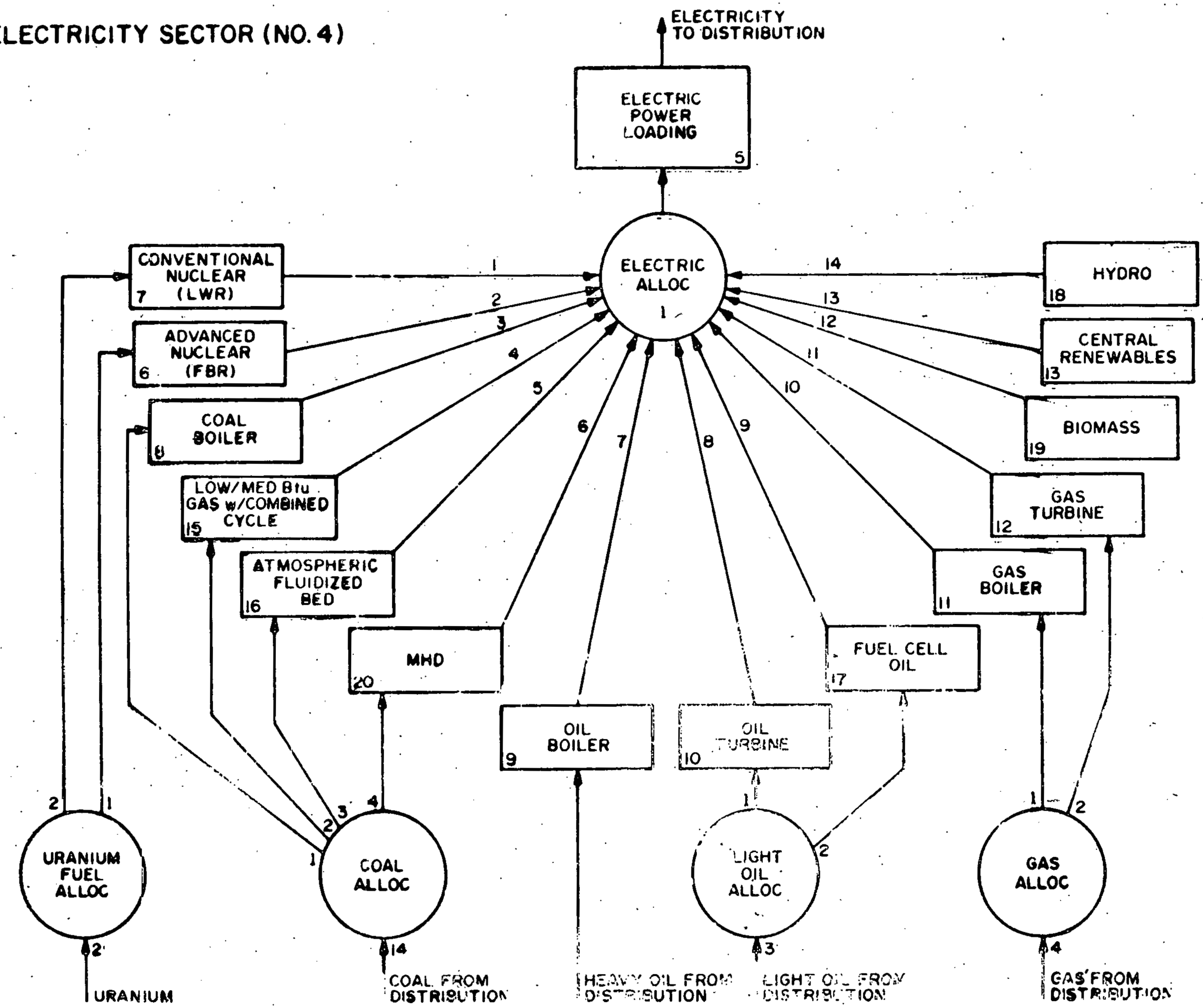


Figure 5.3

These are the various ways of satisfying demand for electricity that comes down from the demand sectors in this model.

Going on down the network, I'll show you a supply sector.

(See Figure 5.4)

This represents coal; these nodes represent the various ways we can deliver coal into the system. The bottom nodes represent the supply decisions that one makes by region: western coal (low sulfur) on the left-hand side, ranging to Appalachian high sulfur coal on the right hand side.

Each of these--take the center one, mid-continent coal--can be used in three ways. Coal can go up to be "mid-continent high Btu gas" or into "mid-continent liquids" or to "direct coal consumption," for example, by the utility sector, and so on.

The fuels are then transported through the network.

Now, in summary, I shall say that there is nothing very innovative about the network approach. Exactly the same description of the mid-range model can be made because, in fact, there is an actual network structure behind all energy models.

The difference here is that it is more explicit, and I hope you can relate rather more closely to it than to a conventional description.

Now, let me talk briefly about one of the simulation modules that occur inside that sector and give the characteristics of it. It solves the local problem of planning optimal capacity over a 50 year time horizon.

(See Exhibit 5.2)

What kinds of decisions should one make knowing what the 50 year future is going to be, given that you have demands and fuel that you are purchasing at a certain price.

COAL SECTOR (NO. 6)

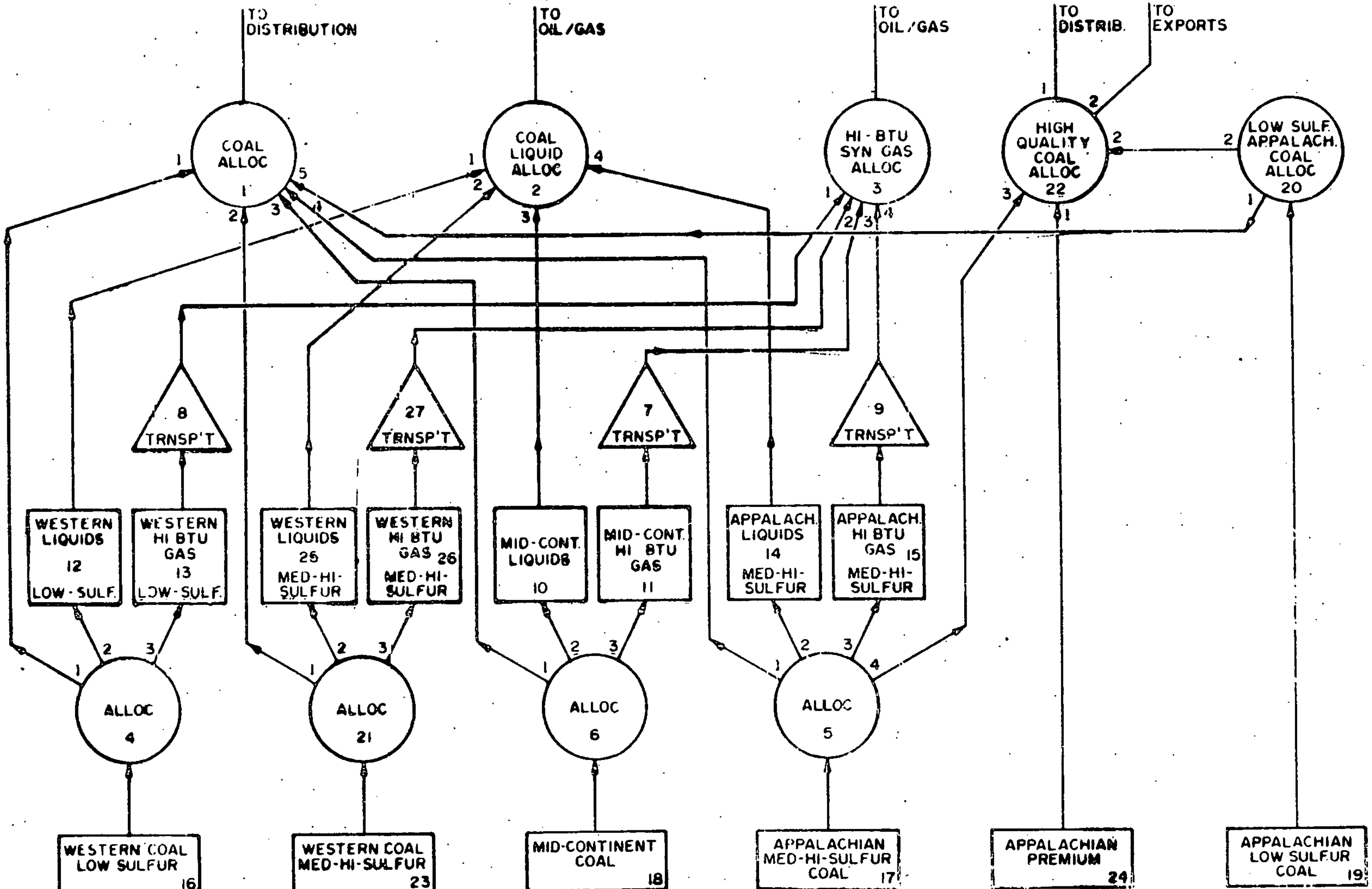


Figure 5.4

CHARACTERISTICS of a SIMULATION MODULE

- Solution to local optimal capacity planning problem over a 50 year horizon.
- Explicit treatment of - financial decisions
  - capacity vintaging
  - learning
- Easy replacement of a module to adapt to the application.

Exhibit 5.2

It's a problem which can be solved in many ways. The technique we've used is an approximation to optimal capacity planning.

Inside the capacity planning decision is an explicit treatment of the financial decisions which have to be made in determining the capital stock; capacity vintaging (the fact that you have 50 years of capacity that you're keeping track of, and retire); efficiency improvements (the fact that as you go forward over the 50 years, there are various kinds of technology improvements); capital investments (each new investment may be cheaper); and so on.

All of these are variables that we would like to keep track of in doing a long-term modeling calculation.

Finally, yet another thing I should point out: it's very easy to redraw the network and plug in a new module if we don't like the one we have. And, in fact, we are rapidly producing a library of these things. Although it looks like we have only four basic types, I think we have ready two dozen or so different versions of the four types, as we make variations on them to represent different problems.

Now, before I go into the actual results. I will make the point that demand is the most important aspect of the long-term projection problem.

As far as I can make out, there seems to be no supply problem whatsoever in the long term. There are many ways in which we can produce energy; the question is: just which ways can we afford?

Thus, the real problem is modeling demand, to figure out what it is we do need. It's very important that we get the level, at least the range of relative levels right, because, presumably, if the ranges are low enough, maybe we'll make do with just the oil and gas that we have in the ground.

If the range is high enough, we've got to do something a little more imaginative. If it's very high indeed, then all of the bells and whistles that DOE is supporting really have to be plugged. If it's quite medium, then we don't need half the things that we're investing in.

So the demand is really the key in long-term forecasting. And, in my opinion, we really do not put enough emphasis on it.

Let me just show a range of results.

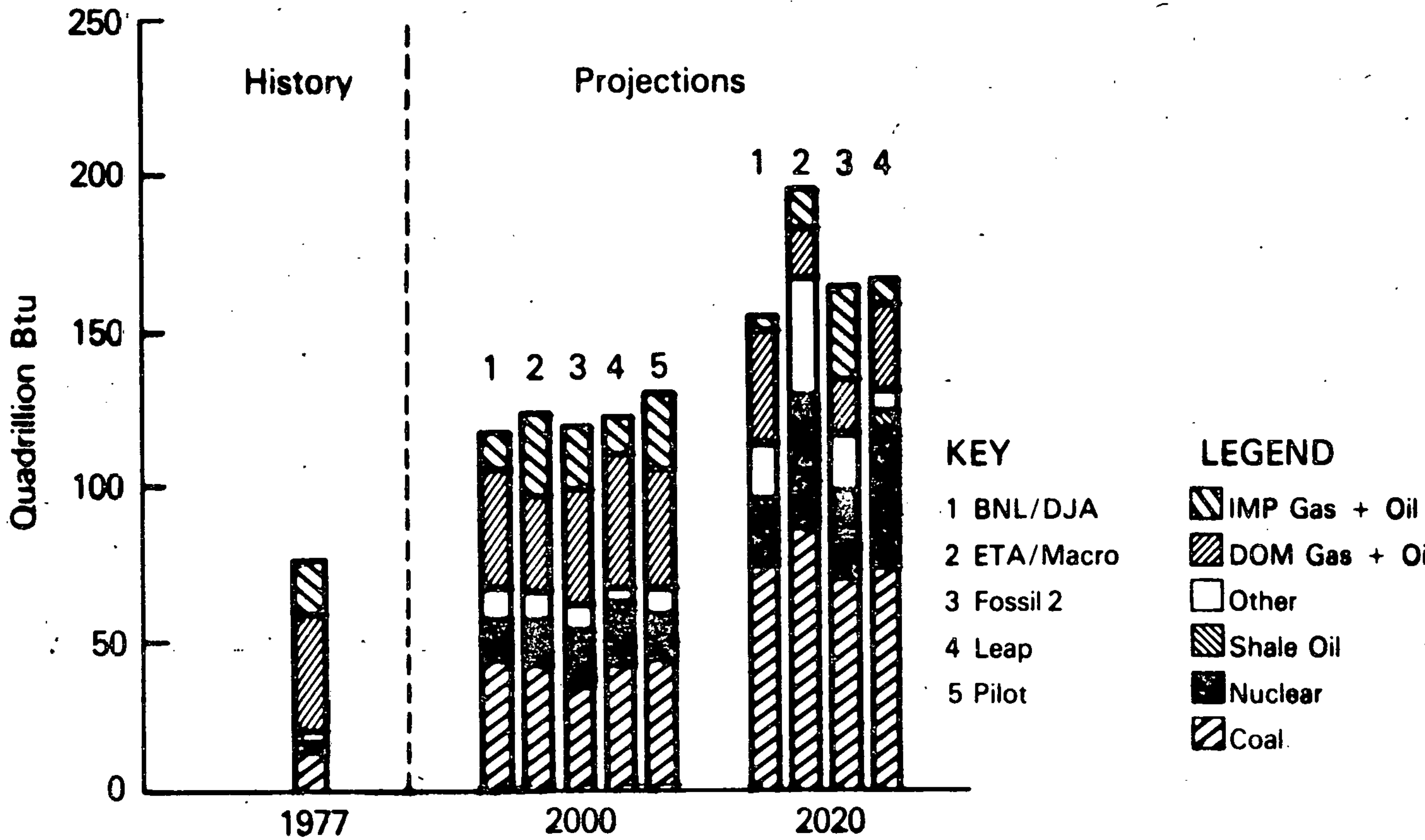
(See Figure 5.5)

First of all, this was the first time we had ever run this model. It was delivered in November 1978.

We finally established a data base quite late, perhaps by about February or March 1979, and got satisfactory results just in time to make the press in April 1979.

As part of the exercise, we also managed to run four other models in the process, and to conduct a forum in which five models were compared with the same basic assumptions. The stated purpose of this was to show that there is quite a range of uncertainty due principally to the fact that different modelers are involved doing the forecasting. Even with the same basic assumptions they will get different results.

Another, perhaps implicit benefit of this, is it shows that LEAP produced broadly comparable results to the other models and the general forecasts are all about the same, e.g., if we take the year 2000, what we have on the slide is a comparison between models. Model one is a combination of Brookhaven and the Dale Jorgenson Associates macro model. Model number two (ETA/MACRO) is a much smaller, much more compact model. Model three (Fossil II) was born at Dartmouth and adopted by Roger Naill in DOE/Policy.



Comparison of Primary Energy Consumption Projections

Figure 5.5

Model four is the LEAP model and model five is the Pilot model (a second generation, detailed energy-economy model based on the original Pilot model developed by Professor George Danzig).

Different models give different results. The results are all more or less the same in terms of overall level in the year 2000, the key level. In the year 2020, they start to diverge. Let's look particularly at the LEAP results.

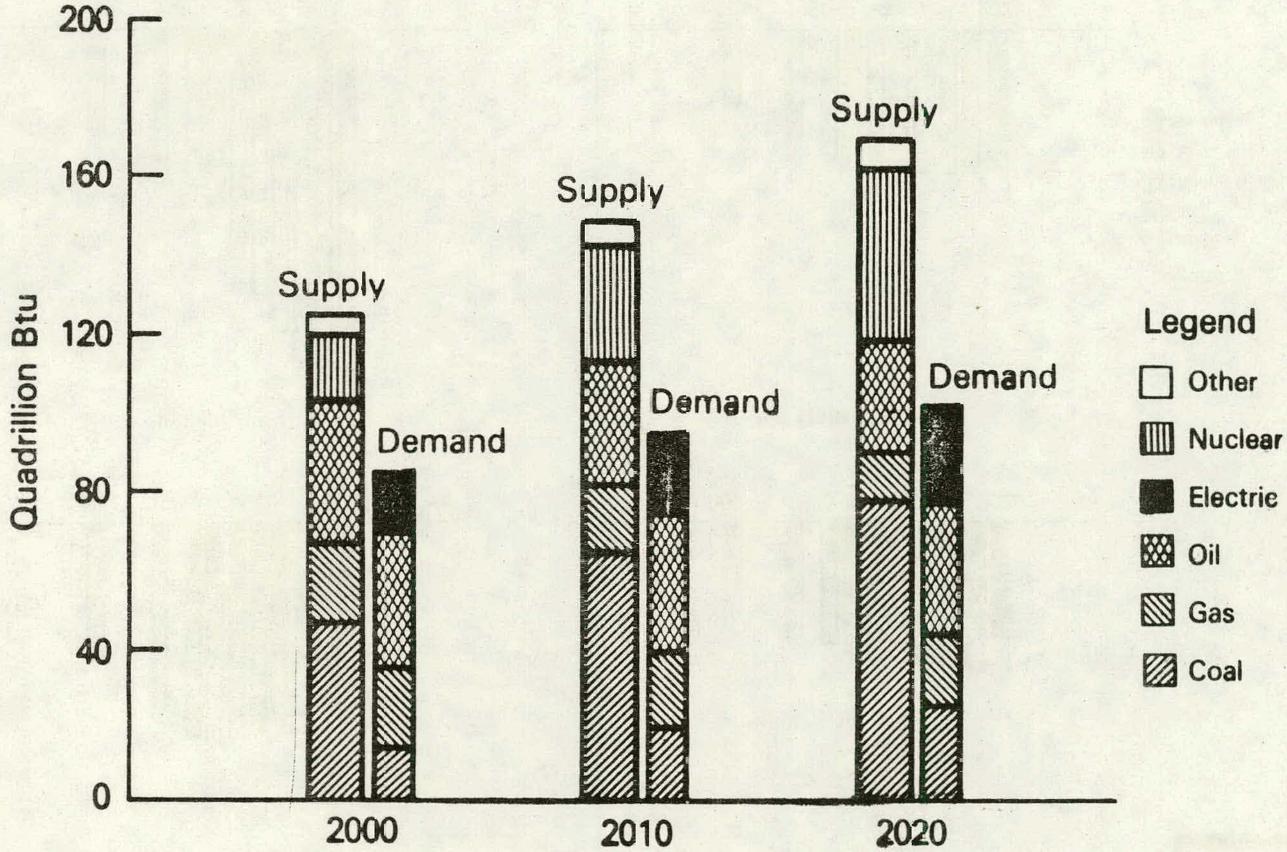
(See Figure 5.6)

For the years 2000, 2010, 2020, what these show is the difference between supply and demand. Supply is what we put into the system; demand is the actual energy that we measure being consumed. It's not service demand. Service demand is way down here. Again, service demand is the actual useful energy service we derive.

Now, you can see (if I can reconstruct this) that there is a steadily increasing component of coal all the way through. The electrical component increases steadily throughout, and the oil and gas sector stays remarkably constant, which makes you think that maybe we're not going to run out of oil and gas after all! However, in a few more slides, I'll show you where the oil and gas comes from and its coal.

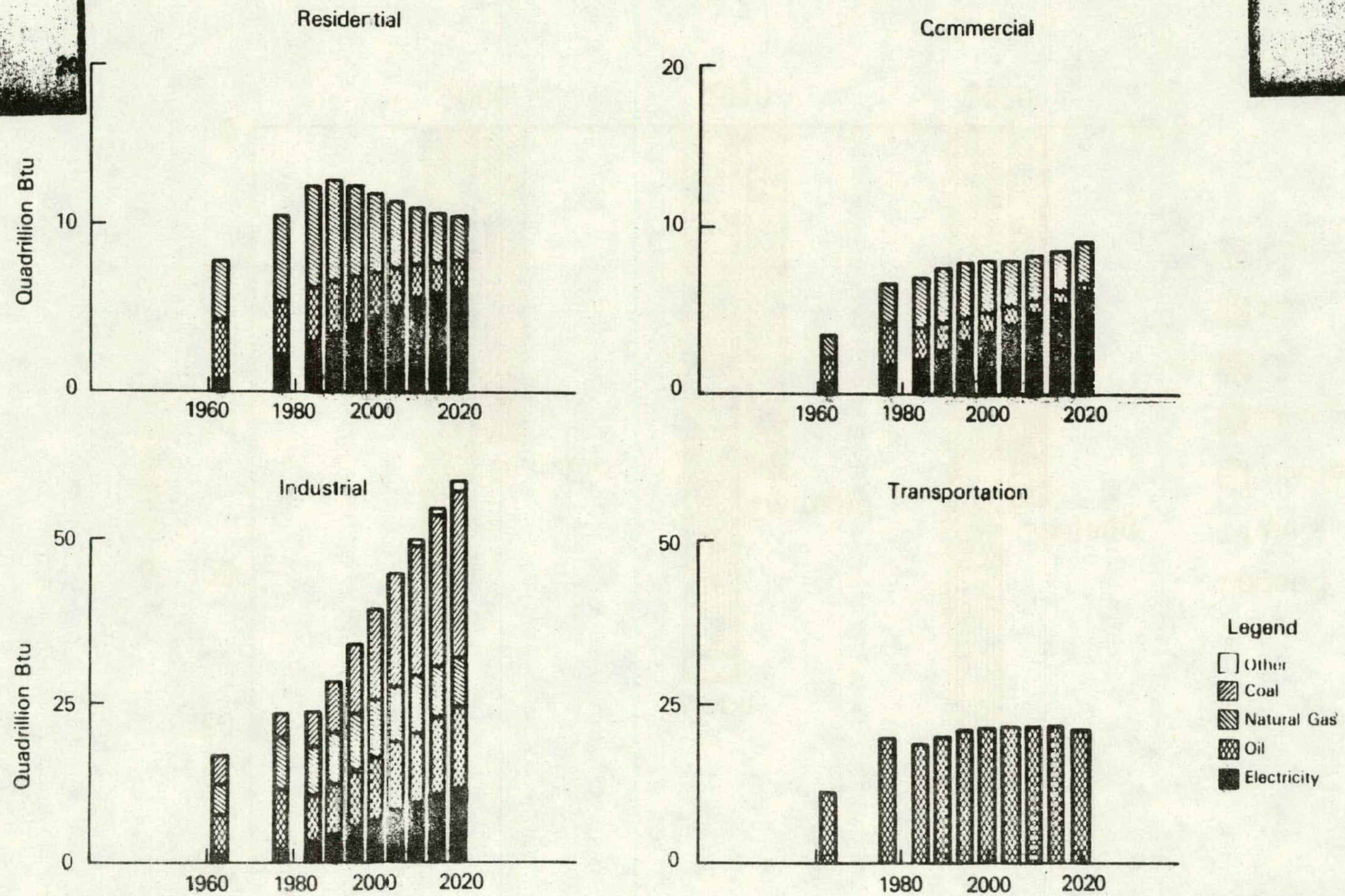
(See Figure 5.7)

The next slide shows the four sectors: residential, commercial, industrial, and transportation. Everybody worries from a solar point of view about the residential sector. That's the top left part of the slide. It represents a peak of about 12 quads, which according to our forecast occurs shortly before the year 2000. Commercial demand rises steadily to 10 quads by the year 2020, but the growth is not very high.



Comparison of Primary Energy Supply and End-Use Demand

Figure 5.6



End-Use Energy Consumption by Sector

Figure 5.7

Transportation is steady at about 25 quads. But industrial demand rises steadily from about 25 quads to something like 70 by the year 2020. As you can see, the action really is in industrial demand.

Now, one may ask: where are renewable resources going to play their principal role? Well, it's probably going to be in residential demand and, clearly, it's going to be peanuts. The real energy growth is in industrial demand where solar technologies may have least effect. That's even allowing for the very heroic kinds of assumptions we had to make to cut it down to 70 quads.

If you look at some of the other forecasts, you'll find that the growth really is in industrial demand. The 200 quad type ERDA forecasts were all in industrial.

I think I have time to summarize the kinds of changes we made in the demand structure to get this kind of a pattern. I will do that very quickly.

Residential, we assumed there was increasing thermal integrity, that there was increasing penetration of technologies like heat pumps. The heat pump is probably the most innovative technology that we know now that actually works.

In the transportation sector, we assumed that the rising demand for auto transportation vehicle miles would taper off to something like the population growth, and that the fleet average fuel standards would rise to something like 35 mpg by the year 2020. This may be low, but it is a fleet average, remember, even though Volkswagon is talking about 80 miles per gallon for diesels, not everyone will buy them.

The commercial sector we assume would grow pretty well with the GNP.

Industrial, we slackened off very dramatically over the 50 years assuming a 50% reduction in requirements per unit GNP.

Let me now show you very briefly where the energy comes from.

(See Figure 5.7)

To start with, on the electrical side, with the data we had, coal and nuclear dominate electrical generation. The question as to whether it's coal or nuclear depends very much on uranium pricing or whether we want coal or nuclear to be allowed to grow that much.

We really did not put any constraints on coal or nuclear at all. Uranium resource curves were perhaps a little flat, and hence the uranium growth--the nuclear component is quite high.

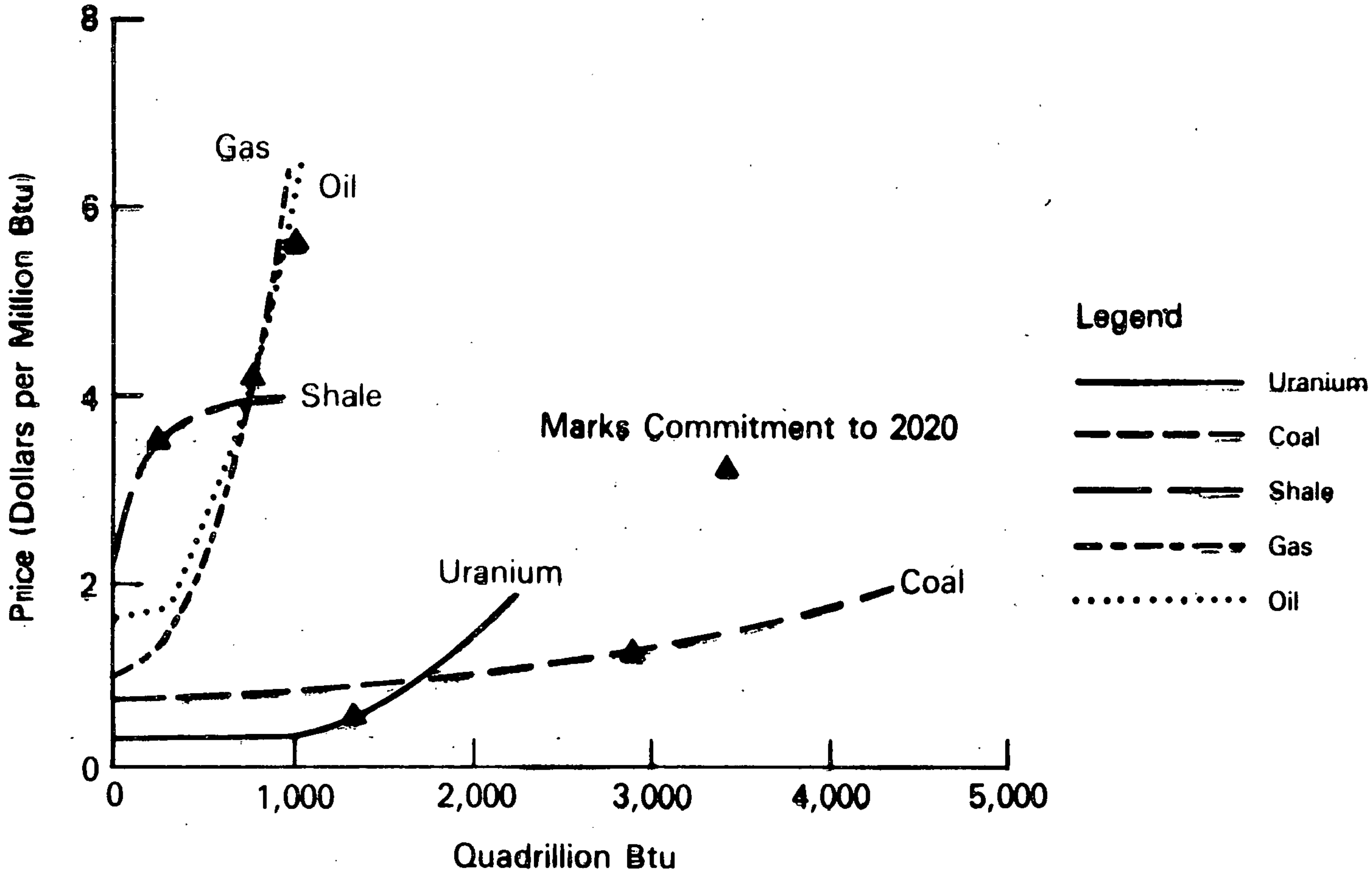
(See Figure 5.8)

It's interesting to see how far we went up the U.S. resource curves of marginal cost versus commitment. This graph is rather cryptic. It shows how far we committed the resources we know exist in the U.S. The triangles on the slide say that by the year 2020 we had that much of the reserves in production (not that we had produced it).

As you can see coal is still pretty flat, and we were not quite to the 3000 quad level, committed to mines.

Uranium is starting to be more expensive--we think perhaps it should rise much quicker--whereas oil and gas were getting pretty well up the supply curve due to depletion.

The peculiar shale curve allows for the fact that shale initially might be cheaper but, if we have to start delivering water to it, then it's a bit more expensive. Otherwise, it would be quite flat. Thus this graph indicates that levels of resources will be committed by the year 2020.



New Resource Prices Increase with Cumulative Development

Figure 5.8

Now I will flip straight to where liquids--gas and liquids come from.

(Figure 5.9)

As to gas, the shares of gas stay pretty constant beyond the year 2000. The reason is that coal produces synthetic gas, basically high Btu bas.

Conventional gas drops off fairly rapidly beyond the year 1990--2000, despite a component from enhanced, Alaskan and imports.

(The side bar lines represent the corresponding mid-range forecast, and I put this up, in part, to jog you to ask questions as to why there is a difference.)

Similarly, in oil, even though total oil production is pretty constant beyond the year 1990, it's really picked up by synthetics.

(Figure 5.10)

Imports start to trail off beyond the year 2000, and conventional oil, as we know it, is pretty well dropping off.

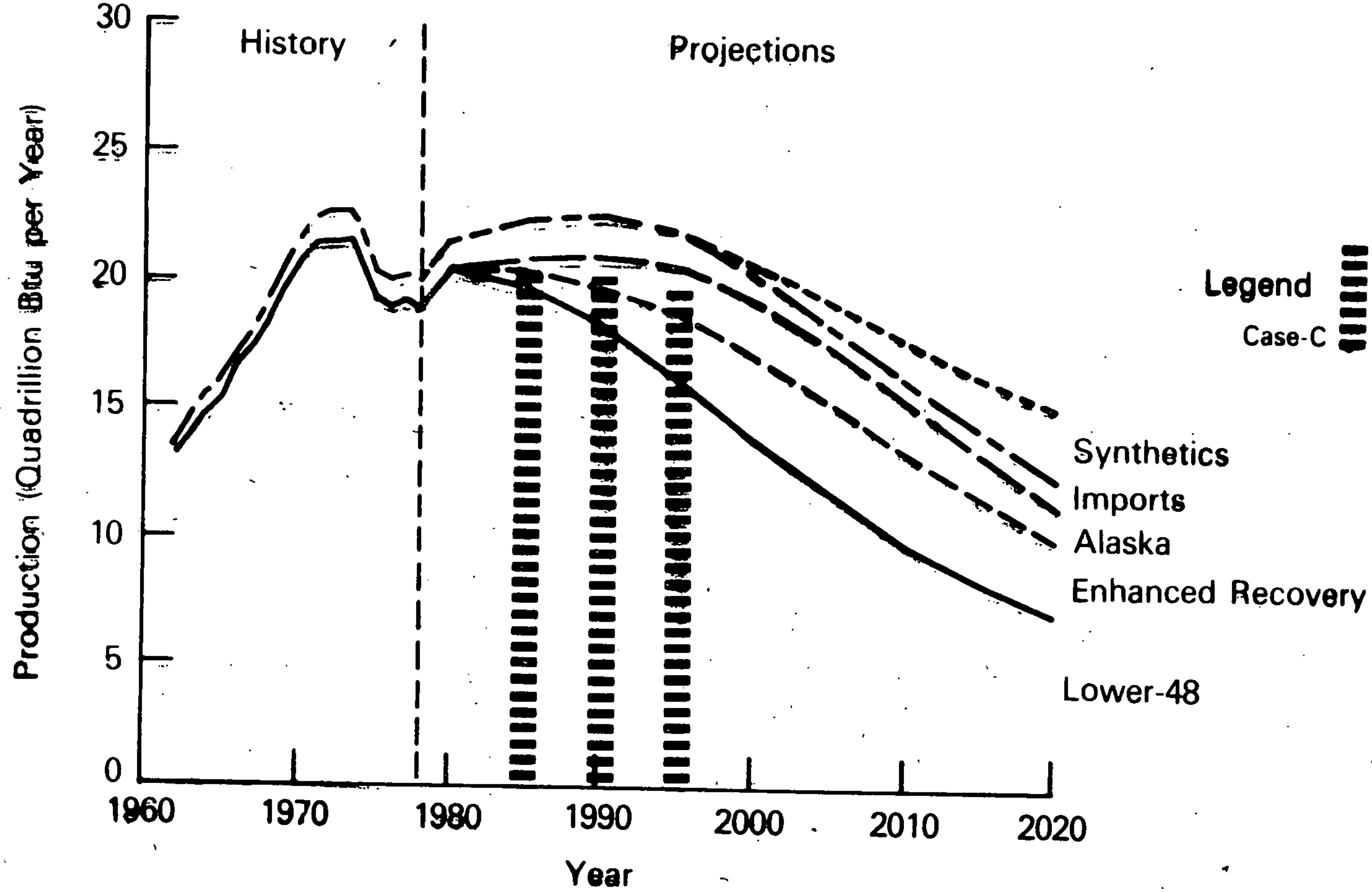
Shale, Alaska,enhanced recovery, imports, and synthetics are keeping it up to those levels. Clearly, what we are seeing here is the transition, perhaps, from the oil and gas age into the coal age.

But there is still oil and gas consumption. The supply side is changing, but not the demand side.

And I'm going to stop right there.

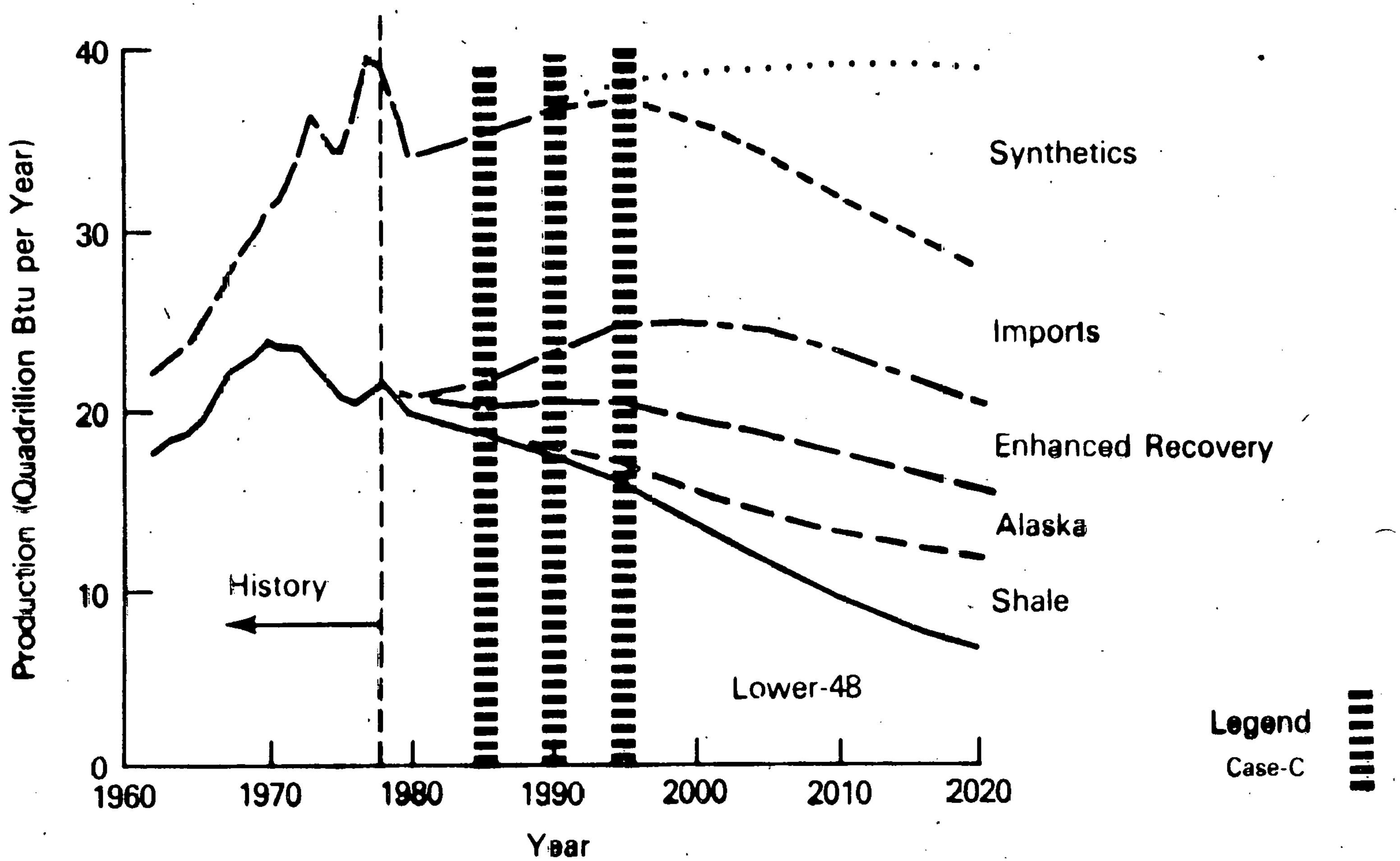
DR. ALT: Thank you, John.

We would now like to turn to the non-EIA sector for responses to John's comments. The first person we have invited along these lines is Dr. Kenneth Hoffman, who is Senior Vice President for Energy and Environment with Math-tech, Incorporated.



Total Gas Supply by Source

Figure 5.9



Total Liquids Supply by Source

Figure 5.10

DR. HOFFMAN: I'd like to remind people that the long-term chapter in the Annual Report was about 24 pages; the thrust of my comments will be to indicate why it should be increased to about 50 pages in the next report. I'm not recommending a similar expansion in the rest of the report; the long-term section should get about 20 to 25 percent of the total report.

It is clearly necessary, however difficult, to do long-range analysis. It is very important to have some explicit perception and explication of the future as a basis for R&D planning, as a basis for long-range policy, and, in particular, to examine the extent to which our near and midterm policies are "locking" us in for the long term. I think the latter question is a good one to ask about any policy: in solving some immediate problem or midterm problem, are we gaining more flexibility or are we making the system less flexible for the long run? In any case, decisions are going to be made based on some implicit view of the future, and I think it's a very healthy thing to make these assumptions, perceptions, and viewpoints as explicit as possible so that they can be reviewed and audited by groups such as this, and by others who might question the kind of policies that are made on the basis of such analysis.

I would first like to compliment EIA on its outreach and its involvement of a wide analytical community in long-term analysis. I recognize that it is difficult to involve external groups in short-term and midterm analysis, which tend to be more policy-sensitive. But, I think it's a very healthy thing to do in long-range analysis. There is a lot of analytical capability and a lot of alternative views and perceptions in universities, laboratories, and industry. I recommend that EIA continue the approach they have used in their first two reports of trying to bring some of this thinking into the annual report.

As I understand the logic of the earlier reports, the previous annual report really looked at a survey of available forecasts that had been done under very different assumptions and reported on those as long-term forecasts. In the current report, more of an attempt was made to put those models and analytical approaches on a common basis by defining a base set of assumptions and key variables. I think that was a very good second step to get a view of how the long-term projections might vary as a function of the model. It was interesting that Dr. Pearson referred to it as a function of the modeler rather than the model; I think that there is probably a lot of truth to that, but I'll speak to this point more as a function of model. I think that the logic of the analytical approach used in the current report was sound, and I think the objectives were achieved. I think we now have a better understanding of how the results obtained using these techniques that attempt this very difficult--probably impossible--job of foreseeing the future, can be explained as functions of the model, modeler, and driving variables.

The analytical methods used reflect a proper balance between approaches that can employ engineering judgment and approaches employing economics that really govern the behavior of consumer markets. With the addition of the restraints of regulations, standards, and technological change that can be represented explicitly, the methods represent the current state-of-the-art. In the analysis of long-run energy supply and demand, we are talking about something very different from, say the defense and space programs where government could decide to deploy a system and is its own customer for that system. Demand analysis is fairly easy under such circumstances.

In the case of energy we have a more complicated economy involving many consumer decisions and we've got to deal with that complexity through econometric and economic analysis.

In my comments I would now like to concentrate on the next steps in this kind of analysis and address the question of what would be reasonable to do the next time around. I believe very strongly in the need to address a wider range of uncertainties which in the long run are very large. There is a wide range of opinion about the course of future events, and I think we need to recognize these uncertainties more explicitly as the appropriate next step, having accomplished what has been accomplished in the first two reports. One of the motivations for this relates to some of the statements that were made about these point forecasts being base cases for policy analysis. I feel somewhat uncomfortable with these base cases because they all look too good. They look too acceptable, and almost any alternate policy you come in with is probably going to have a negative effect compared with these artificial base cases. Such cases, incorporating a number of optimistic assumptions, always look pretty good compared to any other case you want to look at. I think there is a need to have available a base case that has the kind of problems, curtailments, discontinuities, and disequilibriums built in that we know will occur and that will adversely affect the energy system. In long-term analysis, it's necessary to portray such a case as the base case.

Now let me go into more detail about some of the uncertainties that must be addressed and some ways of dealing with them.

First, I would like to start with what I would categorize as political uncertainties. It appears that the supply of oil in world markets is going to be dominated more by political and national decisions than by equilibrium economics over the long term and, probably, over the midterm as well. More and more, the OPEC discussions are in terms of production levels along with prices. At times it seems like they're searching for a price at which world oil consumption will level off and maybe even decline a bit. Perhaps a starting point for analysis of these relationships is to view a quantity of world oil production as a base line. What if OPEC behavior were to limit production to such a level? What prices would it take to come to equilibrium in world markets? The report now includes a case that comes out at about 8 million barrels a day imports, and is fairly level over the long-term horizon. How about adding a case that might look at a reduction of the U.S. share to something like 4 million or 5 million barrels a day? What kind of prices and alternative technologies would that take?

Another set of uncertainties that I think should be explored in more detail are the economic uncertainties. With regard to the question real versus current dollar accounting, I agree with the response that they are equivalent for analytical purposes, but I think one should look more carefully at differential inflation rates. We know, for instance, that over a 10 year period capital costs inflated faster than the Consumer Price Index. Now, whether this was due to a decline in labor productivity in the capital intensive industries or some other reason, I think that the growth rates may be quite different among the costs of energy, materials, and labor. To assume that all of these are going to grow uniformly in the future is probably a dangerous and incorrect assumption. So we should explore more carefully the effects of differential inflation rates among capital, labor, energy and materials.

Also, in the context of economic uncertainties, I would like to return to the projection for industry consumption of energy. There was great agreement on this in some of the previous discussions, and I guess the fact that there is such agreement might give cause for more concern. Given the growth rates in some of the other consuming sectors, I am very uncomfortable in looking at the industry sector accounting for about 80 percent of the growth in energy consumption over the next 20 or 30 years. I have always heard that industry is much more responsive to life cycle costing, price effects, and all of that, than the rest of the economy. One explanation for the higher growth rate for energy use in industry is that the other sectors, such as the housing and automotive sectors, are coming under standards and regulations that will enforce conservation. I would hate to see such an explanation used as an argument for extending standards and regulation to this one sector that is projected to grow more rapidly because it is not subject to the standards that other sectors are.

I'm afraid that what is built into those forecasts is kind of a perception of business as usual in the growth of each of the industry sectors--and I don't know whether we can expect the same kind of growth in basic metals and chemicals, that we've had over the past 10 or 15 years.

Further, we need a better understanding of how the service sector comes in and consumes energy. Is it more energy intensive or less energy intensive? I expect that it's probably of a different character that might be more like the commercial sector. I don't know what the answers to these questions are, but I know that they can have a significant impact on these projections, particularly in the industrial area that seems to account for most of the growth.

I don't believe that we can come down to the level proposed by the Council on Environmental Quality of 80 quads or 60 quads. I think some numbers like that were thrown out. I don't beleve that estimate any more than I believe that industry is going to account for 80 percent of the energy growth between now and the year 2000.

A considerable amount of additional work needs to be done on the demand side, and this applies to midterm modeling as well in the industry sectors.

I also worry about the competition faced by some of the energy-intensive American industries with cheap hydro power in, say, Brazil, and with cheap natural gas and oil in the Mideast. How are these industrial activities going to shift? We've seen TVA and Bonneville are raising rates rapidly for aluminum plants in the U.S. "I've heard where some plants have been canceled because it was anticipated that the utility rates were going to be too high or electric power was not going to be available. We need to look at the possible shifts in the consumption patterns of industry in a global context. This would provide a good link between some of the long-term analyses and some of the international analyses that are performed in EIA.

The third category of uncertainties and surprises that I think ought to be dealt with more explicitly in the next round of analysis fall into the technological category. I think that we have a pretty good view of how shale, oil, and coal liquefaction plants will look. If you look at coal liquefaction technology, even if you could develop some new technology that would do the liquefaction process in something the size of a thimble, you wouldn't have that significant an effect on the price of the overall plant.

You're dealing with a plant that is handling a lot of solids. The cost is dominated by the materials handling problems and the waste disposal problems, and it is fairly insensitive to technological change in the actual chemical conversion process itself.

I think the areas we don't really understand are in the category of end use technologies, and in particular the appropriate scale of end use technologies or the appropriate degree of centralization or decentralization of the energy system. I think it is probably better to address this scale question not in terms of the hard versus soft path which is fraught with social arguments, but rather as a function of population density. We still have a large fraction of people in urban areas and it's going to be very hard to use a lot of the biomass and solar conversion schemes in these regions of high population density. They are more adaptable to rural--possibly suburban--regions of lower density. This is a dimension of regionality that needs to be brought more directly into the analysis. A very good job is done on regional detail and we know that the supply of fuels and the possibilities for solar energy are very region-dependent. But, I think we have to look at this other dimension, particularly, the dimension of population density and the urban-rural split.

It seems to me that there will be difficulties in siting large, central electric plants in the urban areas. This means that there is going to be a great demand for clean fuels, liquid or gaseous, in urban areas.

One possible answer to this problem is natural gas. I don't feel comfortable with the long-run supply curve for natural gas or the way the projections show natural gas going. This is an important area that is subject to large uncertainty. I don't think that the estimates reflect the possibilities for either deep conventional gas or non-conventional gas. In any event, if we're looking for technological change and surprises that would have a significant effect on the way the energy system looks and might develop, I think the gas question is a very important one to look at. I've done some calculations, and it looks as if gas would be a very viable energy source for urban areas using co-generation, where you can exploit both the heat and the power from that gas. In New York City it competes quite well with central station electrical power at an average of 12 cents a kilowatt hour.

The major question is: how much gas could we have at $7 a million Btu or at about the current delivered price of distillate oil. There are some people who think we might have all the gas that we can effectively use at this price. It would be most interesting to look at a more optimistic picture on the supply of natural gas at prices like $6 and $7 per million Btu. Such an assumption would have a profound effect on urban use patterns, so again I would recommend that a closer look be taken at those urban-suburban-rural population density splits and at the appropriate scale technologies in each of these regions.

Other technological surprises that could have a tremendous effect on the energy map are things like fuel cells and aluminum-air batteries. There have been some very promising R&D results on aluminum-air batteries that would promise performance equivalent to an internal combustion engine vehicle. With the aluminum-air system, some analyses indicate that you would have to drain the aluminum hydroxide and put fresh water in about every 200 miles, and change the aluminum plates every 1,000 miles. Now, that's getting closer to a viable electrical vehicle that begins to look more credible as a large scale replacement for vehicles operating on liquid hydrocarbons.

Finally, I'd like to raise a philosophical issue: I think most of the analysis--indeed, the long-term analysis--is being done from the point of view of simulation. Optimization techniques are being used but are heavily constrained. I think there is a need somewhere for a more normative or prescriptive type of analysis. I think that this is similar to the message I heard Dr. MacKenzie giving earier. There is something about the normative approach or optimization approach that has a uniqueness to it as a baseline case. It may not provide a good simulation, but as an embodiment of how we would connect the pieces of the energy system, the technologies, and consumption levels together in the most effective way, given some simple objectives or complex multi-objective function, it has a uniqueness to it that has appeal as a case for comparison with policy-oriented simulations. It cuts through a lot of often conflicting policy assumptions and lets you know where your policies might be moving things relative to that idealized normative case. Although not a good forecast, it is a unique embodiment of the information that we have available to us at any given point in time, and I think, if put forth and represented as that kind of projection, would have some value.

I'd like now to close just with a story about the dangers of extrapolation, if I can take just another 30 seconds. This story deals with technology--the three engine aircraft. Let's make it an L-1011 rather than the poor old DC-10.

This plane is flying from Los Angeles to Washington and one engine fails en route. The pilot announces to the passengers, "Well, not to worry; this plane was designed to fly very well on two engines. The only problem is that we'll get to Washington about an hour later than we are scheduled."

The people feel relaxed. When they get over St. Louis, lo and behold, another engine fails.

The pilot gets on and says, "Really, don't worry about this; we can maintain altitude on one engine. We can land very nicely. But we'll now be two hours late getting into Washington."

Just then someone in the back, probably an econometrician, pipes up and says, "Oh, my Lord, if we lost another engine, we'll be up here forever."

(Laughter.)

Thank you.

DR. ALT: Thank you, Ken.

We would now like to continue with the second speaker from the non-EIA sector, and that is Dr. David Knapp, who is Vice President for the Energy Economics Division of Chase Manhattan Bank.

DR. KNAPP: Thank you, Frank.

I think I would like to start out by looking at two general reasons why one cares about the long run; the first reason is that current prices of depletable resources depend on things that are going to happen a long way out in the time horizon.

In order to be well informed about both the short-term and the midterm situation in terms of energy prices, one has to segregate out what is an exhaustion rent, what is an underlying monopoly profit, and what is the cost. So it is very important that this structure be used, and related to the short term--whatever that is--I didn't really get a good flavor for it in the five minute presentation earlier today.

But obviously with the midterm, there is a very important need to improve our ability to translate long-term scenario specifications into at least a view of oil prices and, hence indirectly, also coal, natural gas and electricity prices in the midterm forecast. The time, I think, has ended for assuming that oil prices are going to be flat.

The second reason why one cares about the long term is that current research and development is going to determine the course of technologies which, in fact, we're using to differentiate the midterm from the long term, i.e., technologies which are not currently in a state of development which will allow them to impact energy supply patterns. And it turns out that that looks like a 10 to 15 year horizon. Those technologies need to be funded in order to come on-line in the year 2000.

I think this is one of the areas where this model structure can be used effectively to inform current government decision making, and this is not being done that I know of, i.e., most of the technology specifications that are in the long-term model are exogenous.

Though there are some endogenous market share penetrations and prices, there is no endogeneity in the sense of having the ultimate timing and the amount of availability and the alternative energy resources dependent on R&D funding.

I think that's an area in the future that our long-term model is going to have to deal with.

I understand that this gets us into an area where EIA's responsibilities to remain objective and to not be involved directly in policy making may put some bounds on how they go about doing it.

Nevertheless, I think having the long-term capability, there is a major reason why we would want to carry it forward.

There is also another associated aspect of the technology penetration. That is, looking backwards from, say, 2050, you know what the right technology was. But, looking forward at it from 1980, there are many candidates, and this inherent uncertainty about the successfulness of any given technology is a very difficult modeling problem.

The current structure is probably not well equipped to handle that, but there are modifications which people should be worrying about to take a probabilistic approach to the success of competing new technologies.

It is not true that money spent on the technology that didn't make is wasted in the short run because of this underlying probabilistic nature of this technology assessment.

First, the remainder of my remarks are more about the methodology that is being used, and I make some suggestions about extensions and changes and then deal with a couple of the assumptions. Next, I feel that some things were left out of the analysis that I would like to see analyzed in some detail in the future. Third, I will discuss the results briefly. Finally, I will make some suggestions about how the report may be made more accessible.

I agree with the network approach for conducting the long-run models. In fact, I probably would prefer it as a midterm modeling technique, but in conjunction with a more detailed representation. At present, the LP structure of the midterm forecasting system does a better job at maintaining the consistency internally in the forecasting exercise.

Once you have used the LP structure enough times with a fairly stable set of outputs, a network approach to that set of problems can be much more efficient in terms of computing time and analyst time. That is, the network approach appears simpler, faster, more modular, and more transportable than large LPs and obviously more than home grown FORTRAN codes which do the same kind of forecasting.

The particular model that came out of the Gulf-SRI exercise is, I think, on the frontier of the network approach to energy modeling. There is a user's group which is slowly developing around it, which includes the LEAP effort at DOE. It also includes TVA, Pennsylvania Power & Light, EPRI, and Chase Manhattan Bank.

We hope that there will be enough division of labor in the topics we each address so that there is a lot of sharing that goes on in this exercise.

I'm excited about the possible contribution that DOE can make in terms of methodological improvements that I think should be made.

I think Dr. John Pearson agrees with me on several of these methodological points. The structure has many unspecified nodes in it currently. For example, there is a financial node with linkages to both the producing and consuming sectors. But, interest rates are exogenous in the model. The flows of funds in the current state of the Chase version of the model and, I think, in John's version are now reported out. So there is a lot of capability there that I'm sure will be taken advantage of.

The specific thing that I'm going to worry about in working on the Bank's version of the model is trying to close that financial logic so that interest rates are endogenous in the model. This will be done by determining the supply and the demand for equity and debt, using rudimentary project type decision making based on node logic for an electric utility or a refinery or any of the particular characterized technologies in the nodes.

Also, the consumer sector is currently open. Here again, some form of neoclassical savings function can be specified where the wages then don't just disappear. Consumers are forced to make decisions on the allocation of their incomes between consumption and investment.

This will be the first step in closing the energy-economy loop that we all talk about but which is very difficult to do in the state of the art mid-range structure that requires running energy models and getting outputs and then trying to put them into the WPI-05 variable in DRI's economic model.

The industrial sector has a very similar characterization where you can look at the economic behavior of those agents interfacing between the energy-economy and the general economy.

TVA has disaggregated the industrial sector and this should give a much better picture of the aggregate by dealing with specific industries.

One of the big failures, I think, in the midterm modeling effort to date--or at least removed one year--is that the aggregate industrial sector is not a very good cartoon of the way the world works. It doesn't get answers which are particularly compelling.

There is evidently so much noise in the aggregate data, because different industries are going in different directions, that elasticities tend to be understated and responsiveness in the models that are run with those elasticities tend to be fairly small.

This may be one of the reasons why we see long-term, high level of growth in spite of increasing energy prices in the long-term model.

Well, one other point that I would like to make on methodology that Dr. John Pearson has already mentioned: that is the learning behavior that could be characterized in the model. In particular, the user can set a parameter that will allow specification of the degree of foresight of the agents in terms of knowing future prices. This can be varied between total myopia and perfect foresight.

I think that this parameter may be an interesting candidate for an econometric exercise based on past data: how smart have people been, given the picture of the world that is in the LEAP model, in forecasting what prices are going to be?

Which shots did they miss? Were they actually in the cards and which things should actually have been anticipated.

In terms of the assumptions that went into the model, first, I was a little concerned that the interface between the mid-range and the long range was not stated clearly. The reader of the report would be more assured if there was a clean interface and the assumptions were consistent all the way through, both in feeding back prices from the long-term model to the midterm and in capital stocks, resources, et cetera, being fed forward from the midterm model to the long term.

The second thing that surprised me is that, in the long-term model assumptions, fusion is notably absent from the list of alternative energy sources. This evidently was an explicit choice.

That is an assumption that I think is probably not well-advised, in any case, since candidate technologies should all be given a chance. In particular, fusion should be looked at carefully. Studies which we are involved in at Chase indicate that the experts have much more optimism about the prospects for fusion than the DOE schedule would indicate. We may not have to wait until 2030.

I would suggest that fusion be looked at in next year's report.

Turning to the results, the energy growth in general looks slightly low to me. In contrast to Dr. James MacKenzie, I see less happening in terms of changes in lifestyle as well as less penetration of conservation technologies. But this represents a legitimate difference of opinion. On the other hand, I disagree with some of the reasons that Dr. Ken Hoffman gave in support of his concerns on residential versus industrial savings. He felt that if the conservation potential is there in the residential and commercial sectors and it is mandated, that there will be a fundamental difference between the homeowner and the industrial producer responses. However, if the homeowner saves some energy, he has no incentive to use that energy to do something else--keeping his house at 90 degrees in the winter because he has a more efficient heater doesn't make much sense.

The industrial sector, on the other hand, has the option of using the energy to make more goods, which it sells to make more money.

So it is in fact the industrial sector that is the sponge which is going to soak up displaced energy. Since my view is that the conservation potential in the residential sector is not as large as others believe, I don't see this happening quite so much.

Thus, I think the industrial sector growth appears to be overstated, and conversely I would forecast higher energy growth in the residential and commercial sectors, especially the commercial sector. I don't see anywhere near the level of conservation coming in the commercial sector as is stated in both the midterm and the long-term models.

I agree with Prof. Clopper Almon on that: even with conservation, one still should see positive growth over the short run. In the longer run, looking at the change in the general mix of the economy, the service sector of the economy is probably going to grow much faster than the individual sector, particularly, the heavy manufacturing sector.

Also light manufacturing type activities, which are apt to get included with the commercial sector, are going to be very electricity-intensive, and hence, in terms of gross energy inputs, will be expanding fairly quickly.

Regarding the fuel mix, I see a lot more natural gas available and somewhat less coal, mainly becuase people don't like to use coal. In general, I'm much more optimistic about the domestic supply potential. I share that with Ken Hoffman.

But I don't see these as criticisms of the model, necessarily. These differences are basically the result of differing input assumptions. This is a very healthy sign since with differing assumptions the structure ought to produce different answers. And, when we start arguing about assumptions, rather than arguing about what data base we're using and what particular form of distributive lag demand function you are stuck with, then I think that is a big step forward.

I disagree slightly with Ken's statement that politics in OPEC may dominate the economics. I think that in the long run they are the same thing, and I think the model structure and the supply node logic in the LEAP model are going to help inform us about this, especially when we hash out the financial characterization in that model as to the value of oil kept in the ground versus the value of oil produced. That is a topic that came up earlier.

General, multiparty, scorekeeping specifications of this model for this purpose are possible and I would like to see this done in the future. I think we will have OPEC models which will tie in nicely with our domestic models.

I will close with a few points on the report itself. I have an interesting perspective, since I went from being a participant in the exercise to being an outside user of the report.

Because of my perspective, I understand how hard it is, but that makes me no less optimistic about all the wonderful things that can be done. In particular, pseudo-data generated by these models would be very helpful in generating small characterizations, which would be of use to activities that are of a lesser scale than DOE's activities. This would allow you to carry around small versions of the model in your pocket.

One way to do that is by having lots of model runs and doing econometrics on the results. Another way to do it is to just have reported in a usable fashion what the aggregate elasticities are, that is, what the general responses are.

The five cases in the report don't quite do it.

Sensitivity analyses which are meant to inform you about the model sensitivity about a specific parameter or specific righthand side changes will go a long way in helping the guy on the street to make quick and dirty analytic decisions about how, say, the U.S. total energy demand responds to a 10 percent change in oil prices.

DR. ALT: Thank you, Dave.

Our final speaker in this session is Dr. Russell Thompson, who is president of RGT, Incorporated, which was formerly known as Research for Growth and Transfer.

DR. THOMPSON: I find the overall developments in modeling work since 1973 to be really significant--first at FEO, then at FEA, and later at DOE. Significant progress was made in synthesizing diverse, complex demand and supply relationships into an economic framework. This framework represents a systematic means to get meaningful estimates of shadow prices for energy inputs and marginal costs of outputs. It is one of the few government efforts where professionals are seeking to integrate supplies and demands.

Some results of these models, however, concern me:

- All five projections show increased electrification with 40 to 50 percent of the electricity coming from nuclear power plants in 2020.
- All of the projections show a decreased reliance on natural gas throughout the period.
- Nuclear power dominates the electricity market in 2010; and
- The industrial demands for energy are price inelastic in the long term for all sectors.

The first issue is the supply response of natural gas to price. Higher prices of natural gas are going to result in significant supply responses. Drilling is at a 20 year peak now. Gas is being sought and gas is being found.

Another issue is electricity and natural gas demands. Much higher electricity demand elasticities can be expected. This is especially true for industry's purchases of utility generated electricity; these elasticities will go from being highly inelastic to highly elastic. At the same time, we are going to see significant substitutions of gas for electricity in heating uses.

Also, another issue is the hidden costs of noneconomic constraints (e.g., environment). For example, regional air quality standards for sulfur oxide will become increasingly costly. These costs are going to pervasively filter through the energy sector and the whole economy. Such costs are going to affect industry decisions in the areas of investment, production, fuel mix, etc.

Still another issue is the question of model validity. The following questions need answers: Do the models represent the real world? Has any effort been made to replicate historical statistics? Has any effort been made to estimate derived demands for fuel inputs? Have we done our homework? Much more validation effort is needed. The burden of proof, as far as the general public is concerned, is going to be upon us.

I have several observations:

Observation 1: In general, the modeling results show that the economy is on an inefficient energy path and will continue to stay on it. That is, primary energy use will increase at an increasing, rather than a decreasing rate over time. This appears to result from the specification of inelastic long-term derived energy demands for all sectors--a highly questionable specification.

Observation 2: The supply response of natural gas to price is significantly underestimated. Much larger supplies of gas from domestic, Mexican, and Canadian sources are going to be produced for U.S. consumption than are forecast. The United States is likely to reach an accommodation soon with Mexico. The situation is all tied up with people, technology, and energy. Both economies will be better off with the cooperative trade policy than a competitive one.

Observation 3: The own demand elasticity for electricity and the cross-elasticity of the gas demand for electricity are being significantly underestimated. We recently did a study for Texas in which a very detailed industry model was used. The following specifications were made: $22 per barrel crude oil, $3 per million Btu natural gas, PSD restrictions for sulfur oxides, and boiler fuel restrictions for natural gas and oil products. Solutions were computed for 1990 endproduct demand requirements. All prices and costs were measured in constant 1978 dollars.

The model was used to compute demand elasticities for utility-generated electricity by industry. Here is what resulted: At prices of electricity of around 2 cents per kilowatt hour, the price elasticity of demand was less than 1; for an electricity price between 3 and 4 cents per kilowatt hour, the own price elasticity was approximately 3; and further, as the price of electricity increased relative to the price of gas, the own price elasticity for electricity was even higher.

Observation 4: We recently verified and validated an electric power model for the United States. An effort was made to replicate historical statistics for two periods: 1965 to 1969, and 1970 to 1974. We started with a relatively simple model; but, three to five-fold more structure was needed to work toward meaningful replication of relevant historical statistics (in terms of fuels used and investments made). Coal qualities, production capacity, retirement, retrofitting, and new build decisions are all very complex. Detailed structure is required to get accurate cost curves.

Observation 5: With regard to pseudo-data, we recently completed an extensive, in-depth effort. One sobering result was found. The size of the relevant economic region was disturbingly small. This is one of the first things mentioned in economics of the firm. An economic decision must be in Stage II, (which means certain properties must hold mathematically with regard to the second differential). In the environment of increasing regulation, the relevant economic region is becoming very small in my judgment. Only small price variations seem permissible. (This may explain the non-convergence of the PIES's model in certain cases.)

Pseudo-data is clearly useful for validating a model. It gives insights into the size of the relevant economic region. These insights are basic for meaningful parameter specifications. It further is helpful to see if the demand curves have the right signs and if the curves show the right types of cross elasticities. But extreme care is necessary in operational uses. Its usefulness for operational purposes is still an open question.

In summary, I would offer the following perspective for long-term energy supplies and demands. We are going to observe primary energy use increasing over time at a decreasing rather than an increasing rate. Only modest growth will occur in utility investments in electricity capacity.

We are not going to see highly favorable nuclear power economics. The economic incentives for investments in nuclear power are going to be very marginal. High incentives for production of gas from natural and synthetic sources are going to result in favorable supply responses to price and reliable economic supplies of gas.

Production function opportunities for transforming raw energy inputs into energy service outputs will be much more favorable for the process industries than for the electric utilities. Because industry will be able to get more work from a given energy input than utilities, more and more electricity will be generated internally by industry for its own uses. Further, reliable economic supplies of gas are going to result in the widespread substitution of gas for electricity in heating uses. Regional air quality constraints are going to result in electricity prices rising relative to gas. This increasing price relationship will further stimulate the substitution of capital (in the form of solar energy with gas back-up) for electricity (and fuel oils) in the residential/commercial sectors.

Transportation demands may only be found in an evolutionary way. As stationary uses of energy adjust to higher prices, locations of capital and people will change. Transportation demands are much more complex than generally visualized. Income effects for gasoline demands may be dominating price effects in certain regions (e.g., Houston). Long-run transportation demands are largely an unknown.

In closing, I would like to say the following: Our nation can move towards an efficient energy path. Unfortunately, DOE's models only show the results of following one path--an inefficient one. The results all reflect price inelastic demands for energy. With elastic derived demands for certain energy inputs, the models would show another polar extreme.

The models need more substitution possibilities to reflect the relevant tradeoffs. This is especially true for industry. Also, the commercial and residential demands need reexamination. In addition, a better structure is needed for transportation demands.

DR. ALT: Thank you, Russ.

We are just about out of time, although I'm sure Dr. Pearson has a few short comments.

DR. PEARSON: No!

DR. ALT: Anybody in the Audience?

J. PHILIP WHITMAN (AGA): I have two questions of Dr. Pearson, both relating to your statement about the long-term model's ability to account for new technologies.

The first question is related to energy supply, specifically nuclear power. As Dr. Knapp pointed out awhile ago, you show long-term contributions from conventional fission and from the breeder reactors, but there is nothing about fusion.

So my question, therefore, is: would it be correct to infer that EIA does not project any significant contribution from nuclear fusion in the long term?

The second question pertains to energy end use, specifically to the statement alluding to the innovativeness of space heat pump technology. My question here is: would it be right to infer from this that EIA does not perceive any long-term market penetration from the combustion gas furnace?

Thank you.

DR. PEARSON: I guess I could answer very quickly: no and yes.

(Laughter.)

But let me take those one at a time.

We didn't include the fusion generation of electricity, although you will notice that we show a steady penetration of electricity in all sectors, which suggests that we go from whatever is happening in 2020 to fusion.

But the real reason why we didn't put fusion in is simply because the model stops at 2020, and according to current DOE plans, fusion possibly will come in about the year 2010, and fusion will have made a very small contribution to the overall results.

In terms of the space heat pump, I said that it was the most significant technology, mostly because it is so efficient. Technologies like solar aren't competing with electrical resistance heating. They are competing with the heat pump.

I'm not really sure I know what the gas combustion heater is, but I do know we're assuming for conventional oil and gas heaters that current efficiencies will continue at about the same level, although it seems to me there is tremendous potential for improvements in efficiency, particularly for things like the gas heat pump.

PARTICIPANT: It has been field tested as of last winter, and it has a seasonal efficiency of about 94 percent. It works on the principle of the old German buzz bomb motor where you have intermittent combustion and the intermittent explosions alleviate the necessity for having the thermal life of the flue.

So that is where you gain the efficiency.

DR. PEARSON: That is very interesting. That would be included in my assumption that the efficiency of conventional heaters will increase dramatically from where they are now.

PARTICIPANT: Thank you.

DR. ALT: Although we're almost out of time, I will allow several more short comments.

PARTICIPANT: Consider the multimodel exercise that the EIA had this year on the long-range forecasting. You displayed on a transparency various modeling systems and the differences between the modeling systems. As someone who has had a chance to examine the projections coming out of the various modeling systems, have you formed any options on whether the answers were very similar, or were they very different from each other for a particular scenario across models?

DR. PEARSON: There's no short answer to that. The answers look similar, superficially. But in fact there were differences in them which stem to some extent from differences of approach and to some extent from differences in assumptions that were made.

One of the things we tried not to do is to tell the modelers how to run their models. We gave them the basic ground rules and said: "You can revise any one of these if you don't agree with them."

And, in fact, some of them did even though the results still looked remarkably the same from the outside.

I think that is the short answer.

They are similar, but there are some fundamental differences.

DR. ALT: Perhaps one more question.

PARTICIPANT: I'd like to address Dr. Thompson. You've made some very, very interesting comments about modeling, specifically, on the work that you've done on electricity elasticities. My question would be, first of all: Have you looked at the potential penetration in the industrial sector using gas? And secondly, if you have, what sort of magnitude of change is there? Is there something that occurs only in the long term, or can you see it in the midterm as well?

DR. THOMPSON: The answer is yes. We have taken into account cogeneration possibilities. Also, we have looked in depth at all the different ways of transforming inputs of purchased electricity, natural gas, coal, or oil products into steam at different temperatures and using the work to spin turbines, generate electricity, drive mechanical drivers, heat processes, and so forth.

Yes, we've looked at that in considerable depth, and that is the basis for my statements with regard to industrial demands. We're going to find some of these elasticities to be considerably different in the future than what we have seen in the past. And, that is really a very important note for optimism, because with higher elasticities the economy will move toward a more efficient energy path at higher prices of energy.

PARTICIPANT: Can that be incorporated in the system? What about the sale of co-generated electricity back into the grid?

DR. THOMPSON: Our results so far have not shown a great economic incentive to sell the electricity back into the grid. However, they were made for 1990. This may change as the cost of utility-generated electricity continues to increase relative to industry-generated electricity.

PARTICIPANT: Were those national or regional estimates?

DR. THOMPSON: Regional. The estimates were done for Texas.

PARTICIPANT: The numbers you cite are much truer for Texas than for the nation, I suspect.

DR. THOMPSON: There are several reasons why they may be truer. Number one, Texans benefited an awful lot from the Supreme Court decision back in the fifties. A lid was put on interstate prices, but industry could get gas at a price. So, a large amount of industry moved to Texas to get gas at a price. And the industry in Texas is relatively new. It is highly efficient at previous energy prices and previous non-economic constraints.

The question is: Will that industry continue to be efficient at much higher energy prices and much more pressing non-economic constraints, particularly with regard to sulfur?

DR. ALT: I'd like to thank our speakers for this final session. I also thank everybody in the audience for attending this first day of the symposium. I look forward to seeing you tomorrow.

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CHAPTER 6

OIL AND NATURAL GAS

SPEAKERS:

Mr. Charles Everett, Energy Information Administration
Dr. Richard O'Neill, Energy Information Administration
Dr. Edward Erickson, North Carolina State University
Dr. Milton Holloway, Texas Energy Advisory Council
Dr. Edward Murphy, American Petroleum Institute
Dr. Benjamin Schlesinger, American Gas Association
Dr. William Vogely, Pennsylvania State University

DR. GASS: Good morning. This session is on oil and natural gas. We have, as you can see by the names if you're not familiar with the reputations of the people, a very excellent panel to discuss the ARC report dealing with the oil and natural gas area.

You have the program. We're going to go in this room until noon with a coffee break around 10:30 or so. We'll stick with the order of the presentation as it is in the program.

It is indeed a great pleasure to introduce Charles Everett from EIA to give some opening remarks about the report and their views. Charles?

MR. EVERETT: Well, I'm going to keep it very short. This year we had an opportunity to use a few new models. It was interesting to add some new tools to the arsenal. It was also very difficult to go through another year without a resource appraisal from the U.S. Geological Survey, which is probably the single most influential set of inputs to the model itself, or the group of models that we run for the midterm projections.

The report this year is a little bit different than last, because we talk about methodologies a bit more. There's actually a section in Chapter 9 or 10 that is concerned with the way we use these models to make projections by varying prices, geology leasing schedules, cost of wells, and the like. In that regard, we are fairly up front.

I think what I'll focus on, in a few minutes, is a discussion of the principle inputs to the midrange models, which are the geology estimates, and the need to improve those estimates. So that we have a little less disagreement, I think, with the other people around the country that are forecasting oil and gas supply. Before I do that, I will talk just a short while on the short-term oil and gas supply models which are brand new this year and which validate the Fred Murphy thesis that rules work pretty well if you only go out two years.

Certainly, if you only want to go out two years, seasonally, it's fairly unimportant to the crude oil production models. There's not much, if any, seasonality. There is some accounting flutter in crude oil production at the end of each year, but that's largely the result of how the Bureau of Mines uses state records to adjust for accounting errors at the end of the year. The winter also freezes sucker rods in the south and the southwest, I'm told. But, we haven't sent any validation people out to see if that is true. Natural gas production in the short term is seasonal. There is a large working gas inventory and the demand is seasonal.

This is translated back to the supply process. It is not nearly as violent as the short-term production for distillate fuel and natural, which swings quite heavily because of the central and northeastern demands for these heating fuels.

The model that was developed this year was a joint effort of Steve Muzo at ICF, Steve Farmer, and myself at DOE. Up until this point, interestingly enough, all short-term projections that were used were made by people just saying, "This is what I think is going to happen."

We didn't think that was good enough. I think, in retrospect, it might have been. We tried to find some price sensitivity in the short term for oil and natural gas production. We weren't too successful. One of the reasons we weren't successful is it just wasn't that important in the past, apparently, at least from quarter to quarter, and out two years, for either oil or gas production.

Secondly, there are some massive changes going on. One is the Natural Gas Policy Act. The other is what to do about oil pricing. Is it in the current ECPA framework or something new? The projections didn't exhibit any price sensitivity.

Natural gas, out two years, was either slightly increasing or flat crude oil was declining less rapidly than the crude oil production in 1970-1977, which was about 3 percent per year.

I think that the decline rates were something like 1 percent per year; 2, 2 and a half, maybe 3 and a half at the outside. That basically was dull and uninteresting. People, I think, believe the short-term forecasts. It really does work quite well to look at the peaks of domestic production of gas and oil, try to infer from that what annual trends are going to be, and quickly get rid of the seasonal problem of natural gas.

Regarding the midterm methodologies, basically, I am going to talk about geology. Long ago a tactical decision was made to use a model that industry developed in collaboration with the Department of Interior. Various interesting things were done to that model over the space of about 5 years, and it was used again this year for all but the North Slope of Alaska. This includes everything north of the Brooks Range out to and including the Beaufort Sea.

Our recovery model tries to recover from existing fields, those which have already been discovered to date, a little bit more oil. That is basically it. The set of three models, EOR, Alaska and the old NPC type approach, is basically a set of heuristics. Those heuristics revolve around declining rates or reserves, and find rates for new oil and gas. The find rates are where the geology estimates enter in, and those are quite sensitive to two things.

One is the 20 year history of how oil was supposedly found, dividing drilling into reserve additions to get reserve additions per foot for oil and gas. These are largely developed from publicly available statistics from the American Petroleum Institute and the American Gas Association.

The declining rate is limited to what USGS has said will alternately be found, as published in USGS circular 725. There, they have a high, medium, and low estimate for undiscovered resources in that report, which was developed in 1975 on somewhat of a crash basis by the USGS for the Federal Energy Administration.

Basically, as input to the next round, the estimates are again recoverable. What they did in 725 was try to make a guess of not only what was trapped in rocks, as in place resources, but also how much of that might be recoverable. They, on an average in the United States, claim that 32 percent would be recovered from the in place resources.

Looking back, this was probably a bad idea. Now in the latest estimates from the USGS, which is one small basin in Texas and southeastern New Mexico, the USGS and EIA separated the resource appraisal problem into in place resources for the geologists, basically. There was a petroleum engineering group that tried to estimate recovery and costs for drilling equipment and operating. Then, a group worried about the supply curves and how to roll this together and come up with a plot of ultimate recovery versus price. There was no time scale.

This was interesting. As you can see from the annual report, Volume III, by varying between the high and low estimates of geology, you swing these productions around massively. I think this is principally where we disagree with the industry. I'm not so sure that the industry isn't more correct at this point, at least, for some of the regions we've looked at more carefully.

The study concerning the Permean Basin is interesting in that it is about 50 percent of the surface area of region 5 which is the principal region we're talking about in circular 725. If you compare in place resources on a Btu basis, adding oil and gas together, you end up seeing that the new appraisal for the Permean Basin is about one fifth of the region 5 appraisal.

Now, you might say it was half the surface area. This is right, but the Permean Basin is probably the richest set of prospects in that region and probably represents close to all the hydrocarbons that are potentially recoverable.

This is a little disturbing in that you might ask why should one estimate resources very often, if we knew how to do it? Well, we should do it once, because God only did it once. Right. We don't know how to do it very well. This shift represents, purely, a method of logical shift.

What was done in the Permean Basin study was finding rates, finding histories on a well-by-well basis. We've basically extended that using a Roberts formulation. The fact that geologists, alone, can't do this is startling because we have a U.S. Geological Survey. It is going to have to work in unison with EIA, both the engineering people we have in Dallas that are represented here and the people that know how to draw marginal cost curves, at least to some degree. The weakest part of our projections has nothing to do with geology, at all.

Consider the enhanced oil and gas recovery projections. There is not too much understanding I believe of what technology is going to mean. Getting above the 32 percent recovery is the main objective. You can do this by using heat in the form of steam on shallow heavy oil reservoirs to try and pump out this oil.

But there are all kinds of environmental and technological restraints that aren't well understood. This year, probably, the biggest reason that our forecast is somewhat level out through 1985 for crude oil is that we allow the heavy oils in California to come on basically by using incrementally priced natural gas.

This is a bold step in some direction. I'm not sure that will ever happen, but I did read that over a year ago some thermal operators in the Kern River area had come to burn natural gas to generate steam to inject into the reservoir. This gives you a double punch. You don't have to burn the crude oil you're extracting now.

So, that is available. It also turns out in this model that it is economic to burn incrementally priced natural gas. We have two things to do, the way I see it.

One is to make sure the source appraisals are done as carefully as possible. The second is to make sure we learn how to deal with enhanced oil and gas recovery, because those are the things that are going to pull around the 1985 reserve estimates. Thank you.

DR. GASS: Thank you, Charles. What I would like to do on the questions, today, is hold them until after the speakers finish and then we'll have a panel. Then you can ask questions of the individual speakers or collectively.

I'd like to next introduce Mr. O'Neill from EIA, who will talk about modeling activities.

DR. O'NEILL: Thank you Saul. If you'll look at your program, Dave Hulett was to follow me; but, he was forced to go to Paris this week to explain the Three Mile Island report to a group of Europeans. He didn't want to go to Paris. He wanted to be here, but he told me that the State Department insisted that he be in Paris.

The reason I'm 'ere is because just recently there was a change in the guard in the Oil and Gas Analysis Division at EIA. Charles Everett had been running the group until about three months ago. Since then, the job has been mine. I would just like to say that we welcome and thrive on debate of the various issues in oil and gas analysis. We love to exchange letters with the governor of Texas and Dr. Holloway on finding rate methodology.

So, I'm ready to take input from anybody who is willing to give it to me. I would like to say a few things about what we are trying to do now. We are developing and have under development new methodologies for on-shore oil and gas production projections, both new fields and old fields. Basically, they try to simulate the exploration and development process and get a little bit away from the current finding rate methodology that is in use.

In the off-shore area, we are also bringing on new methodologies that consider questions like the availability of transportation systems as constraints. Also, we are undertaking a rather ambitious project to do structure by structure evaluation in the Gulf and actually do a fairly detailed simulation of finding activities.

Like Charles said, we're looking for inputs on how to improve the way we analyze enhanced oil recovery.

One of the chief new thrusts of the analysis exercises is to make the computer models as modular as possible. We have learned that the government will propose new controls; they will propose new regulations; they will propose new taxes. We want the models to be modular and able to handle new controls and new proposals as they come along.

I think that runs the DOE portion of this session to something only like about 20 minutes, at most. I'm going to sit and listen to people that have no connection with the Department of Energy and let them criticize, make suggestions, and critique what we did.

DR. GASS: Thank you, Dick. Moving on with the panelists, our first speaker this morning will be Dr. Edward Erickson from North Carolina State University. Ed, do you want to come up here where we have a speaker's microphone?

DR. ERICKSON: Well, it's a pleasure to be here at the University of Maryland, even though I come from North Carolina State.

I think that there are more important things to think about than the particular details of the current version of the ongoing effort of the EIA modeling activities, as it is imbedded in the overall information gathering, processing and dissemination industry which deals with energy problems.

Therefore, I will not focus my remarks on whether or not the finding rate methodology is appropriate or inappropriate; or, what sensitivity analysis could be done in that regard, because I am confident that those sensitivity analyses will be done--both from internally generated EIA critiques and from externally generated activities. There will be ample opportunity for this clearly desirable testing.

I think the larger and more important perspective in which modeling activity needs to be evaluated is the perspective of what motivates us to build these models, what motivates us to collect this information, what motivates us to analyze it. That motivation is ultimately a policy concern.

The policy problems, if one steps back and looks at them, have a large component that is analogous to the smaller components of our ignorance which Charles Everett mentioned. That is, we do not know; we do not know what the resource base is.

Petroleum geologists, oil and gas economists and others make periodic reappraisals. And those reappraisals--and the frequency of those reappraisals--

can be looked at as an index or extrapolation of our ignorance. We do not know--we just, quite frankly, do not know.

We do know several things about the resource base, though, and those several things that we know about the resource base are important. First of all, for oil and gas and for other minerals, the distribution of their occurrence in nature appears to be approximately lognormal. There are very few very large deposits and very many smaller deposits--how many, how exactly distributed, unfortunately, we do not know.

We also know that the larger deposits, to the extent that they can be identified and are accessible, tend to be drilled first, because they look more attractive. This occurs both within a given play and, for the North American continent, as a grand play.

Typically, the larger structures are easier to identify. Also, their economics are more attractive. Now, where does that put us in terms of the policy arena? Can we extrapolate from those simple insights to the policy arena within which the models that EIA operates, and the information gathering and reporting that it accomplishes?

The answer to that, I think, is approximately yes. The large perspective we must have is that our whole experience over the last quarter century and for the next quarter century is going to be dominated by a single, extraordinary, natural phenomenon. A natural phenomenon which in the lognormal distribution of things, if one were somehow to compare it to the aggregation of Mount Everest, the Grand Canyon, the Amazon River, and Niagara Falls, might be several steps out on the Richter Scale from there.

The natural phenomenon is Ghawar, the principal oil field in Saudi Arabia. For all intents and purposes, in the quarter century following World

War II, Ghawar came on from zero million barrels a day to 10 million barrels a day and was absorbed into the world energy economy.

It is unlikely that there are ever going to be any additional Ghawars discovered. By comparison, one needs to look at Prudhoe Bay, a candidate for the largest oil field on the North American continent to date, as being considerably smaller than Ghawar. The reason one must be imprecise is that we may have considerably better information about how big Prudhoe Bay is than we do about how big Ghawar actually is. That is still a piece of information we do not have.

In the book, The Little Prince, by Saint-Exupery, there is a central metaphor which involves a picture which the Little Prince draws and which looks, essentially, like a floppy hat. The little Prince is very distressed that nobody can recognize the profound truth that the picture is of an elephant inside a boa constrictor.

That metaphor is relevant to the energy policy environment, because Ghawar is, essentially, an elephant inside a boa constrictor. The boa constrictor is world energy demand and Ghawar, the elephant , has been effectively integrated into the demand system, and is, in fact, somewhere in the neighborhood of half-way digested.

What that suggests, then, looking backwards and looking forwards from this point in time is that we are not looking forwards towards a period of unusually high energy costs.

Rather, we are looking backwards towards a period of unusually low energy costs. Thus, if one were to make some hip-shot judgment about "normality" with regard to energy costs in the next quarter or half century, and relate prospective energy costs to the whole stream of human history behind us, the future is going to be more normal with regard to the kind of energy costs that have been typically associated with human experience.

Now, that does not mean that these are energy costs which we are going to like, because the facts of life are that energy costs are going to be substantially higher than they have been in the last quarter century. The political process exists for people to express what they like and what they do not like in action terms, but the scope for such action is ultimately limited by economic reality. So, we must expect, both internationally and domestically, short-run political impacts on what are, basically, long-term economic cost and supply and demand considerations. Thus, over the next quarter or half of a century, we will experience an adjustment back to normal energy costs. However, since time seems to be so compressed of late, the adjustment process that I envision will be much more rapid than the quarter of a century perspective I have been discussing. Coal is the currently known, ultimate back-stop technology. We are a fossil fuel economy and are likely to continue to be a fossil fuel economy for some time. In the year 2000, we will still be predominantly a fossil fuel economy. Oil and gas will still be the dominant fuels, but coal presumably will have a much more prominent role than it now does.

At what level of costs does coal really come in? Well, if you pick an illustrative number, I would say energy costs at an equivalent of $50.00 a barrel for crude oil. Now, we have a long way to go from world energy markets, picking another number, illustrative only, of $25.00 a barrel to get to $50.00 a barrel. And we in the United States have a long way to go domestically from where we now are, even to where the world now is, which is about $25.00 a barrel. That is going to be politically contentious ground to cover.

It is going to be ground that is argued heavily about. The arguments are going to take place in the context of modeling activity, where various numbers are taken as written with a fiery finger and used as battering rams in the legislative process.

In that regard, both from my intellectual, academic, scholarly point of view, and also in my legislative-analytic role, as a part of the lobbying process, I have to applaud EIA's integrity and its devotion to the idea of modular approaches. Modular approaches are advantageous for several reasons. First of all, they, by the very nature of the multiplicity of them, imply and reveal our fundamental ignorance. Secondly, a modular approach is, in fact, much more amenable to incorporation of new information and new policy constraints and policy packages. There are going to be many, many necessities to do that as we try and traverse the intermediate run from here to what this idea of "normal" energy costs might be.

Third, multiplicity itself is also an implicit recognition that there is not a "the answer." In this situation, the famous Chinese dictum, "the way which can be described is not the way," is apt. This is a recognition that if one has many descriptions of the fundamental phenomenon, then that phenomenon is implicitly not very well described. That is not EIA's fault. That is the fault of our fundamental ignorance.

Now, how do we remove, eliminate, repeal, roll-back some of the ignorance which afflicts our modeling efforts? There is really only one way to do that.

The only way that we can do that is through drilling. The old saw of the industry is ultimately the final axiom: there is no sure proof of the presence of oil or gass--or its absence--other than the drill bit.

The lease bids for the Destin Dome are, I think, ample evidence on the one side of that. On the other side, history is littered with the bones of many now-dead geologists who said, "I'll drink all the oil that is found in Illinois," or "I'll drink all the oil that is found west of the Pecos," or even, "I'll drink all the oil that is found in Saudi Arabia."

Fortunately, they have not been called upon to do that drinking.

But we know from the idea of an approximately lognormal distribution of resource occurrence that there is a large intensive margin of crummy resource base out there. Knowledge of this intensive margin can only be revealed through intensive drilling effort which simultaneously generates additional oil and gas and more information about the geological terrain that we are probing.

My personal bet is that, in the year 2000, we will be somewhat surprised at the pessimism associated with our resource estimates in the year 1978, or 1979, or 1980, but there is no way now to know that definitively.

I hope that we will have the drilling experience that appropriate economic incentives, contentiously wrought through a merciless policy process, can provide. But even with that experience, new information yielded to us by nature will have to be continuously reevaluated on a modular basis with different perspectives focusing on different problems.

In that regard, I think we're fortunate to have the EIA to take the lead in that activity.

DR. GASS: Thank you very much, Ed. I'd like to move on to the next speaker, Dr. Milton Holloway from the Texas Energy Advisory Council. Milt?

DR. HOLLOWAY: I'd like to focus my comments on four areas. First, I will raise a question about the purpose for the administrator's annual report. Second, I will discuss some problems of methodology. Third, I have some suggestions about the presentation format within the report. Fourth, I have several detailed comments about the oil and gas section of the ARC and the oil and gas models in particular.

The reason I'm worried about the first question (the matter of the purpose of the administrator's annual report) is that I have been recently examining the role of modeling, and modelers, and so on, in the policy process. I have some very definite ideas about how modeling in the policy process ought to be done. As a result, I have some questions in my own mind about the appropriate institutional arrangement for EIA.

What is the purpose for the administrator's annual report? I know that the legislation creating EIA requires such a report. I know that in the report it says that the Congress has said that EIA shall do this. However, I think that it could stand some interpretation past that. It seems to me the only logical conclusion one can draw for going through this exercise (the ARC) is that its purpose is for government planning activities. It is not for industry planning; it is clearly not that. In addition, the report probably has some general usefulness for the population at large in forming opinions about our future energy situation. I think the ARC has value there, but I would like to see in future reports some expansion about why it is important to have the administrator's annual report.

It says in the report that prices are central--"the central goal of the projections is to determine the degree to which energy price increases can be expected to continue into the future. It is for this reason that supply and demand are carefully studied and equilibrium prices carefully studied in the EIA system."

The conclusion is that between now and 1990, energy prices will rise on the average of between 2 and 5 percent. So, they have, in essence, constructed and used the modeling system to reach that primary conclusion. So, my question beyond the basic one that I just raised is, if indeed prices are the main focus of the study, and if that is the Congressional mandate being fulfilled, then why don't we see more of the focus in the report on the basic price question. Do we, indeed, face for the long term, rising energy costs that are inescapable, and what kinds of policy implications are there surrounding that basic question?"

So, if you assume that prices are really the main thrust of the report, you might come out with a different approach in the report. I can think of a number of studies that have done that--they, essentially, examine the question of whether technology will offset the rising prices that we now face and allow us to move through the next century or so with level or declining prices, again. My suggestion is that you pay more attention to this central issue in next year's report.

The second matter is the issue of methodology. There is throughout the report a hodge podge of methods used. There is some explanation of why the methods are chosen, but not a great deal. There is one set of methods used for the short term, another for the midterm (which is basically an attempt to model supply and demand components of the energy market), and still another for the long term. The long-term method was basically to extend the series C midterm projections using some other models and studies to add new technology information. My question is what does it mean to mix these various methodologies? Is there a better way? Why did you choose this set over other alternatives? Is there really some empirical basis for your taking this approach? I would like to see some additional explanation on the choice of methods in the report.

Continuing on the matter of methodology, I think there is some confusion in the sections on the midterm market model. The section starts out by providing a fairly typical textbook description of supply and demand functions--quantity as a function of price, affected by other factors which shift the function over time. But, as we look throughout the report, at least in the oil and gas section, there is an explicit statement on page 179 that "price quantity pairs created by this modeling system are different from conventional supply curves in that they are directly related to a set of preselected price paths which increase over time."

What does this mean? What are these functions? If they can't be interpreted as traditional supply functions in economics, then what are they? How should we interpret them? How might they differ from the conventional understanding of supply functions? Would they be more elastic? Less elastic? What exactly are they?

A third methodology problem that gives me some trouble (I have looked in detail at this modeling system, because we in Texas have spent the last year or so doing an evaluation of it) is the matter of the price paths. It is obvious that the prespecified price paths heavily influence both the supply and demand sides of the midterm market model. And yet, it is not at all clear how the analysis procedure goes forward when some disturbance is inflicted on the model. It is not clear that there is a complete recycling to generate a new set of price paths that are entirely consistent over the time period. The procedure simply isn't clear to the reader.

There is a fourth point concerning methodology. I would like to see in the report some brief discussion of the general problem of modeling a complex system. As I have already mentioned, there are a number of possible approaches which could have been taken. What we have here is a mixture of regression models, linear programming models and engineering process models. My interpretation of the system is that it is really intended to simulate the behavior of an energy market in the United States, as it interacts with the economy in general.

There are other ways--a general systems simulation approach, optimization, etc. There are a number of approaches to modeling, so I would like to see some discussion of why you chose to use this particular approach.

I will now turn to my third topic on the presentation format. As I looked especially at the oil and gas supply section, there is an abundance of results from the modeling work. There are five series maintained throughout the report; there are various sensitivity analys s results and so on. You included lots of model output results. We also find some sensitivity analysis of key parameters, a comparison of forecasts with history, and finally some comparison of EIA results with selected other forecasts.

But I see absolutely no report of empirical work bolstering up the modeling approach itself. For example, has the oil and gas indusdry, in fact, made investment decisions based on only marginal prices as a simple economic theory of profit maximization behavior says they should?

It seems ironic to me that, after 6 years of modeling by this group and its predecessors, there has not been a major thrust in doing empirical work to make sure that there is some consistency between simple conceptualizations of economic theory, which form the framework for the model and the system, as it actually behaves. I would like to see some attention to empirical work in future reports.

This problem gets more difficult over time. In particular, I think a new problem that we now face is how various parts of the industry behave under a regime of intensive regulation that is much more all inclusive than ever before. How do firms really behave under the new uncertainties of regulation as opposed to the more free market situation. I don't find any such discussion in the report.

Now, I will discuss the matter of details in the oil and gas section of the report and the oil and gas models, in particular. There is evidence throughout that section of a major emphasis on sensitivity of results to certain key variables: price, resources, drilling, equipment costs, leasing, and so on, and the recognition that other factors may be important that can't really be analyzed.

There is not, however, any systematic analysis of the relative importance of these factors. It is clear, I think, to probably almost everyone here that the matter of the resource base is critically important. There could be some standard measures developed to exhibit the behavior of the modeling system relative to changes in key parameters or input data.

For instance, in the evaluation exercise we recently completed, Stone & Thompson did some simulation runs with the oil and gas model and calculated arc elasticities with relation to price, the discount rate, and the drilling rate.

The findings, generally, come out as follows: there is a tendency of all elasticities to decrease with increasing price. Price elasticities are highly sensitive to the finding rate, the discount rate, and the drilling rate. Those for gas range between .2 and 3.7, depending on the level selected for the three factors. The elasticities for oil ranged between zero and 15. Stone & Thompson found that supply projections are generally more sensitive to the finding rate than to the discount rate, especially at higher prices. The impact of the drilling rate is generally less than that of the finding rate, and frequently exceeds that of the discount rate at higher prices. These are examples. The general conclusion from our work was that the models describe an industry behavior that is heavily dominated by the method for calculating finding rates. We did not analyze changes in resource base. But it is clear that, as has already been said, this factor is of great importance in modeling the supply of oil and gas. If I had to rank how a model behaves, I would say the resource base certainly is the most important factor in the model for long-term projections. The finding rate is the most important for the near term.

Anyway, it seems possible to reduce the main behavioral characteristics of the model to a standard measurement. I think that would give us a better idea of the sources of uncertainty in the results.

There is in the report the statement that the change in cost--a 10 percent change in cost in the gas model gives us a 10 percent change in production over a 17 year period; and a 10 percent change in cost in the case of the oil model gives us a 7 percent change in production over a 17 year period--indicate that it is likely that gas is more responsive than oil to price changes.

However, if one looks at the production projections, it appears that it's the other way around: the oil model seems to be more responsive to prices over the low to high ranges examined than is true for the gas model. That is counter-intuitive, at least; the conventional wisdom is that gas is usually more plentiful than oil and should be more responsive at prices in the ranges now evident in the market place. I think this needs some explanation.

The second problem I see in the oil and gas section is that the results are always reported in terms of interactions with the midterm energy market model. That is, the display of the behavior of the oil and gas model is always constrained by the equilibrium prices coming out of the market model. I think we'd learn more about the behavior of the models if they were decoupled; that is, we could see if the models behave in a way that we would expect.

We could see, for example, if drilling allocations between oil and gas change with the relative price change in oil and gas and if, eventually, production responds in the same way; it is hard to get that when you're constrained by the equilibrium prices coming out of the equilibrium system. I think there should be some display of the behavior of the oil and gas model independent of the rest of the system.

The third matter in the comparison of results with other forecasts is important. FEA, and now EIA, when compared to other production forecasters, generally have come out on the high side. I'm not sure that that could be explained, but the forecasts seem to come out on the high side, relative to both other government models and certainly as compared to industry models. Some explanation for this result would be helpful.

It would also be helpful to look at the change in EIA's (FEA's) view of the future for oil and gas production as it has changed over time. These reports have been published since 1975 and this is the fifth national energy outlook by the agency. It would be interesting, as well as instructive, to know how the outlook under similar conditions has changed over time and what the institution thinks they have learned from trying to model oil and gas production.

There is in the 1978 ARC some comparison with last year's report, but that gives you a very limited perspective. Also, I found it curious that there are no comparisons with the Fossil II model operated by Policy and Evaluation. There are such comparisons in other sections of the report, but not in the oil and gas section. I found it somewhat curious that these two modeling exercises exist within the Department of Energy and little attention is given to this fact.

My final point has to do with some specific criticisms of the models themselves, based on our work in Texas over the last year. I will briefly summarize these. EIA is already well aware of these, so I won't bore you with them.

The oil and gas projections, it is clear, are significantly influenced by the finding rate in the midterm and by the resource base in the long term. The implication of this finding is that the finding rate needs to be looked at more carefully. I think it has already been indicated that this is being done in a new modeling effort by EIA, but it seems that the current finding rate methodology likely overestimates the expected finding rate in the near term future.

The second implication is that major work needs to be done on the characterization of the resource base. This has already been discussed by others, so I won't go into detail. EIA does have a current work program to do this.

My second point is a general one that I have already made. There needs to be a much better empirical base for the behavior of the industry as represented in the model. Specific questions are: does the industry, in fact, respond only to marginal prices in investment decisions for oil and gas production, or is cash flow also important? There seems to be some discrepancy between the discount rate used by the EIA model and that reported by the industry as their decision making criteria.

Thirdly, the investment decision process in the industry needs to be studied in general; especially, the role of capital rationing, the role of internal versus external financing and the importance of various sources of uncertainty on the investment process, especially the new regulatory climate.

The third area of criticism is in the matter of the actual behavior of the model on the computer. I've gone through that already.

The kind of results that I've listed need to be checked out, not just by us, but by EIA and others. Some of these kinds of behavior results ought to be included in the report.

I have made a number of suggestions about added material. I'm sure that all of you have noticed that the report is already about 400 pages in length. That's Volume III only; there are Volumes I and II, plus there are Supplements 1, 2, and 3 that must be about 1,000 pages all together. So I wouldn't suggest that you add to the volume, but you might want to consider changing the balance somewhat.

DR. GASS: Thank you very much, Milt. I think they're going to put it on a computer tape and send it out to everybody. I think we have enough time to get one more speaker in this morning before the break.

If we do that, that will give us enough time for questions later on. So, I would like to move on to Dr. Ed Murphy from the American Petroleum Institute. Ed.

DR. MURPHY: I shouldn't hold up the coffee break, because my remarks should be fairly brief. One of the reasons they'll be brief is, quite honestly, I'm not sure I'm the right person to be here.

When I was called to be on the panel, I said one of the things that we're not allowed to do at API is to forecast, since we are a trade association representing the petroleum industry. We are not allowed to make forecasts because of the anti-trust laws. There is an interesting history behind this. It would evidently be all right if we forecasted, as long as our figures or estimates turned out to be wrong.

If they were ever right, there would be a real question about whether those forecasts were, in fact, forecasts. So, I told them I don't see why, in view of that, we shouldn't forecast at will, but I have not had much success there.

(Laughter.)

So what I will talk about, briefly, are some of the general principles or problems that I saw with both the way in which the EIA has done its work as well as the reasons that it began down that path.

Obviously, as Dr. Holloway was saying, the law requires it. So that, in itself, is a very good reason for making the estimates; but, I think, we need to go behind that and ask how are these estimates to be used? I'm led to believe that the data are going to be of most help, going to be put to most use in the government decision-making process, in both the legislative and regulatory areas.

In order to make intelligent decisions--decisions which are being made right now about whether or not we're going to have a synthetic fuels program and how much it will be funded and what type of technologies will be subsidized--we've got to have some idea of what the relevant parameters are; what the prices are going to be; what the supply curves look like; what the demand curves look like many years into the future.

Those decisions, right now, are being made, I believe, in the absence of any real knowledge of the relevant parameters. I think this is one of the needs that the EIA should address.

There is a problem with government decision-making in the economic environment. The problem is that there tends to be one or relatively few decisions made. For example, we either have or don't have a synthetic fuels program; and, if we have a synthetic fuels program, we find a very limited number of alternatives are explored. It's important; it's critical in fact that decision-making be made in an environment where we have the best possible information on what is going to be--what supplies are going to be and what the effects of these decisions are going to be.

Which is a way of saying that we need an estimate; we need a figure; we need a number recognizing and, in fact, I think, one of the major constributions that EIA has made is to point out the many uncertainties. But recognizing the uncertainties nevertheless, these decisions are being made. They're being made with implicit and explicit assumptions about what the future is going to look like. Better they should be made with explicit, I think, than implicit assumptions, because, at least if they're explicit we can criticize them and discuss them and maybe come up with some alternatives.

So that, I think, while the discussion or the elaboration of the uncertainties is extremely important and is, in itself, a valuable contribution, we need some sort of estimate or best guess or an EIA look into the future.

I say that recognizing that there is a danger here; a danger of introducing what I might call the DRI syndrome.

That is, once you have a forecast, once you have a common volume that everybody is reading, then you notice all the forecasts tend to come together.

Everybody is reading the same material; everybody's numbers look about the same. But I'm not sure that this reflects a lack of dissent, as opposed to a lack of real thinking about the issues by many people. I think that is the danger. That if EIA came out with a forecast it would, in fact, be assumed to be the truth or the government's--maybe the country's estimate--of what our future energy picture is going to look like.

I'm not sure whether my next point is a complaint or not, in view of the number of pages in the report. Indeed, I'm a little apologetic in even bringing it up. The EIA work, as opposed to most other work that is done in this area, has tried to tell us what went into the forecast; how it came about; what the uncertainties are; what the assumptions are. This has provided the reader with a way to judge whether we think the forecasts are reasonable. We've been given a range, from which to decide which assumptions we think happen to be most accurate; and perhaps thereby, to end up with a forecast or an estimate that we, the user, believe in. However, our ability to do that, given the information available in the report is somewhat limited. It is limited because we don't really have any detailed information on what the structural properties of the models are; what the actual equations are; what the standard errors are. Were I looking at this for the purpose of using the forecast I would want to know very explicitly and exactly what went into each of the models; how they were constructed; what sort of confidence we had in the various estimates of the models, etc.

I say this somewhat apologetically because the report, itself, is already voluminous.

Moving on a little bit, and this is more in the nature of a comment--in looking at where we're going to be, even in the short-term, let alone in the long-term modeling, there is, as EIA points out, a tremendous amount of uncertainty. But, I am very ill at ease in handling these uncertainties. Ill at ease because I'm an economist. I'm trained as an economist, and I don't see the major uncertainties and problems as being primarily economic. I see the major uncertainties as being geological--is there oil and gas? Are we going to find the oil and gas?--and political.

Frankly, I don't know which is more significant. Political uncertainty exists in the sense that we're making decisions right now in the United States that are going to affect our energy future, that are going to affect how much other energy sources we have.

Certainly on a world-wide basis the uncertainties, as we have seen in the last year, are primarily political. They are certainly not economic. What happened in Iran this past week was certainly not economically motivated. It had severe economic repercussions, but you can't say it's economically motivated.

This is, of course, not a problem or criticism of the EIA model. But, in using their model I'm ill at ease in dealing with the uncertainties because I see the uncertainties as something about which I have a limited amount of information and a limited ability to handle.

As I said, I think one of the major contributions of the EIA report is that it does give some understanding of the uncertainties and some understanding of what effect different assumptions will bear in the future. They didn't dodge the issues, and I think that is very good.

I think the reader is given a very good perception of what it is that is going to be driving the energy balance 5, 10, and 20 years from now. The methodology, I think, was sound. I like the approach; I like the supply and demand interacting with a price equilibrating mechanism.

I think that is a sound approach. I think that it is much better than what we had in the past with a gap approach, which I found very difficult to deal with. I think we could have seen more use of this approach in the short-term model. I, for one, am convinced that the events of the last year have shown us that there is a very significant effect of price on both supply and demand, even in the short run. So, I think that's something that, perhaps, can be strengthened. As I said, it's difficult to get very specific because the specific detail of the model is not in the report, itself. One of the questions I had in going over the report, for example, was how did the strategic petroleum reserve come in?

I don't know, quite honestly, how it should be incorporated in something like the long-term or the midterm model; but certainly it does affect our security. Presence of strategic reserves reduces--in effect--reduces the implicit economic cost of importing oil. In essence, it provides us with a way of dealing with the risks, the risks due to a rising possibility of interruption.

That, maybe, needs to be addressed or incorporated at least in the midterm and long-term model.

My last comment is one of the "damned if you do, damned if you don't" variety.

In the long-term model, we've only got one set of assumptions, as opposed to the midterm and short-term. But, I tend to view the long term as much more uncertain, for the usual reasons. So I think more of the effort, more of the analysis, should be directed at trying to see what the maximum range of this uncertainty is in the long term. I believe the long-term model in particular should provide us with an estimate of the effect of various uncertainties--economic and regulatory uncertainties, demand, supply and technological uncertainties.

I think unfortunately the series C forecast, the series C estimate, despite the cautions in the report against it, is going to be taken as the forecast or the estimate because it is the mid-range. I think that is unfortunate. I certainly can't say that if I had to pick a forecast this would be the one. Thank you.

DR. GASS: Thank you, Ed. We have a couple of minutes before the coffee break.

PARTICIPANT: Since I've heard quite a few times references to the size of this volume, I'd like to have some quantitative indices. How large is this volume?

One reason is I'm thinking of carrying it home.

(Laughter.)

How many man-hours went into it? What's the size? How many cubic feet are we talking about?

(Laughter.)

DR. GASS: Has anybody got the data?

MR. EVERETT: Okay, there are about 150 to 170 analysts in the plot analysis office of EIA. They work a good part of the year on this problem. It is expensive.

The third part of the question raised the cost issue.

An approximate figure is $40,000 per person, per year.

PARTICIPANT: Does that include the computational costs?

MR. EVERETT: No. The budget in 1980 is $50 million and the people in the whole organization number 700 or 800. So, EIA is a reasonably powerful organization. I have to remind you that there is a group out in Denver called the

Solar Energy Research Institute. They're about as big as us and they worry about things that don't exist.

(Laughter.)

PARTICIPANT: What is the number, finally, for the cost? What would you estimate the cost to be?

MR. EVERETT: We'd have to estimate that especially for you. I don't think we've done that. It's hard to separate out. Other people work on the inputs to the model. Other agencies participate to some degree. It's an expensive process. I'm not sure it's a meaningful number, either.

PARTICIPANT: I just wanted to get some feel.

DR. GASS: It's like estimating the reserves, I think.

DR. VOGELY: Saul.

DR. GASS: Yes?

DR. VOGELY: I might just say that I asked that question at a meeting with the Acting Director of the Bureau of Mines about four years ago. What was the cost of doing contingency planning analyses? He said, "Zero because all these people will be employed and working in the government anyway."

(Laughter.)

DR. GASS: There's an opportunity cost in terms of what else you could be doing. Yes?

DR. VOGELY: Unless you assume the alternative value to be zero.

PARTICIPANT: I have a comment on something that Dr. Holloway said. I think he said something like simulation market equilibrium on one hand and linear programming optimization on the other hand.

The impression I got was that there is a very large difference between these two methodologies. That somehow, this model was trying to put all those things together. I think a more useful distinction is econometric versus process analysis.

I think there is so much econometric work that could be done in linear programming, and so much process analysis work that could be done through simulation. A lot of market equilibrium concepts could be interpreted in linear programming contexts.

So I throw this out as something to think about. A more useful distinction is econometric versus process analysis than optimization versus simulation.

DR. HOLLOWAY: Well, there are both econometric and process models in this structure. That is one of my questions. Are those basically compatible? And, what does it mean to put those kinds of modeling concepts together?

PARTICIPANT: We have done econometric and process modeling since the end of 1950. Is that telling you anything?

DR. HOLLOWAY: No.

PARTICIPANT: You can always have skepticism.

DR. GASS: Thank you. Why don't we take a break until 11:45 and we'll meet again in this room.

(Brief recess.)

DR. GASS: Could I please have your attention? We'd like to continue with the session on oil and natural gas. In this respect, we have two more presentations and then we'll open it up for general discussion. The next speaker is Dr. Benjamin Schlesinger from the American Gas Association. Ben?

DR. SCHLESINGER: Good morning. I want to thank you for asking AGA to participate here in the EIA roast for a two day session.

(Laughter.)

It is my pleasure to participate in that we have been one of the groups that have written a lot of letters to Dr. Moses and the various good people who work in his organization concerning forecasts of oil and gas.

AGA is a trade association representing the transmission and distribution companies for natural gas, supplemental gas, or any other form of methane that we're able to provide. We are generally not producers; however, I heard Ed Murphy's comment that forecasting is illegal when done by trade associations. If it's true, bring on the Federal Marshals, because we do a lot of forecasting at AGA.

I have no knowledge that it is against any ruling.

(Laughter.)

The group within AGA that has the responsibility for forecasting is the policy evaluation and analysis group. We're involved--briefly, by way of introduction--with three energy models.

The TERA model--Total Energy Resource Analysis--is our own system which was originally developed at the time that the PIES model was, 6 or 7 years ago. It bears many of the same kind of structural features as the old version of PIES.

We have rewritten TERA entirely, or nearly entirely, over the past two and a half years. We also have a committee of gas industry individuals who work with us and advise us in the use of that model. In addition, our group works with the Wharton econometric model for macroeconomic analysis, and with the ISTUM model for special industrial studies.

My comments, this morning, are directed at the results of the EIA's natural gas forecast, specifically. It is one of the most dire forecasts, as a whole, that I have seen. It is a generally flat or downward sloping forecast for the role of gas energy itself, reflecting a diminishing role for gas energy in the U.S. energy picture.

It is not unlike that of the President's first National Energy Plan, which phased gas out of existence entirely by the year 2030. We don't agree with that forecast and we've done some study in our group to determine why it went wrong.

Let's look at the two sides of the equation and evaluate them, supply and demand.

First, consider supply. The TERA model, the EIA supply model, and about a dozen others or so are participants this year in Stanford University's Energy Modeling Forum.

Since we are both participants in that, we have had a chance to review and critique each other's models. This has enabled our staff to gain some familiarity with the EIA supply model for conventional gas.

In addition to that, our Gas Supply Committee of AGA, which consists of about a dozen of the top chairmen and chief executive officers of the large gas pipeline and distribution companies, held a workshop earlier this year and considered a number of factors that underpin forecasts of gas supply. In effect, five conclusions grew out of that workshop. I'll relate them to our knowledge of the EIA model:

(1) First, the resource base estimates, primarily, are really not all that different. They may differ up to 50 percent, but when you consider how much things could differ, that is really not very much.

In particular, the estimates of Potential Gas Committee, which is the industry's main resource base estimator for natural gas (a counterpart to the Geological Survey activity), have been relatively consistent over the past 20 years in terms of the size of natural gas resource base. Some 1,200 Tfc (trillion cubic feet) is the current resource base estimate. The Geological Survey's estimate is not really very different from that. Shell, Mobil, Exxon, and others do vary but, basically, the general conclusion in the first of the five supply areas is that the resource base for natural gas is not really a constraint to continued production of natural gas at significant levels for this century.

(2) Second was the issue of current statistics. This gets into the price response issue. We see significant evidence based on current statistics that well drilling and exploration activities, in general, respond to price. It is that simple.

The Natural Gas Policy Act has some 20-odd categories and there are a number of criticisms of the bill, simply because it has 20 categories and it's kind of confusing. But, if you spent a week studying each category, it takes you 20 weeks to understand the Natural Gas Policy Act.

People understand it now and they're out there drilling. Exploration is at record levels. In particular, deep gas--one of the categories that will be deregulated next month--and deep well drilling are up 20 percent over the previous year, which is a particularly noteworthy statistic compared to the last five years.

Also, shale activity is up significantly--again, one of those categories that will be deregulated next month. Other indicators are also showing these initial signs that the Natural Gas Policy Act appears to be working.

We won't have complete statistical evidence on this effect until another full year has elapsed. The 1979 statistics won't be available until early 1980 and, even so, the first full operational year with the deregulation of the hard-to-get-to categories won't be reflected until the 1981 statistics, reflecting the full year 1980.

So, it will be some time before we think we have any definitive evidence. But, all the right signs are there. That summarizes our view on price response.

(3) Third, rig availability. Here, we don't see any major constraint, again, to a 10 to 15 percent increase in exploration on an annual basis. AGA conducted a special analysis for this purpose, whose details I won't get into now.

(4) The fourth area was our review of energy models. Here, we were assisted by the Energy Modeling Forum activity. Once again--perhaps it's this "DRI syndrome," perhaps not--the EIA supply model appears to be fairly consistent with our own TERA model, as recently revised, and with the NEP-II forecast, Fossil-II, and with some others including Ed Erickson's supply forecast, which is available to the group. Ed's forecast also generally falls within the broad range of model forecasts.

I don't really think there's a "DRI syndrome" at work, however. The various models do show different kinds of features that we can get into.

(5) Fifth, a special survey of producers and of major gas pipelines was undertaken by our Gas Supply Committee to determine how and why their forecasts of conventional lower-48 state natural gas production differ. Many of these models are not available to public scrutiny, in particular, Exxon's and some others, but we were able to get some post-NGPA results from them.

In general, we found most producers and major pipelines concurring that reserve additions throughout the 1980s, in light of NGPA, are likely to be in the 10 to 15 Tcf per year range.

Production forecasts generally fell over 16 Tcf by 1985, somewhere between 14 to 16 Tcf or a little more by 1990. After that, the uncertainty range, understandably, increases. NEP-II's forecast was 12 to 14 Tcf by the year 2000. Again, EIA's, TERA's, ED's, and others don't really substantially differ that much from the range that was forecasted by the major gas producers.

Laying on top of this the potential for supplemental gas supplies--supplies from Canada and Mexico, LNG, coal gasification, supplies from new technology--gives us considerable optimism for gas supply over the next several decades.

So, I think that in light of all this information and looking at EIA model in this context, supply analysis conducted on the part of EIA is eliminated in my mind as a cause of the problem with their gas forecast.

Now, let me look at demand. That is the problem. EIA's midterm gas demand model has, in our minds, understated potential gas demand in the year 1990 by some six quads--6.2 quads to be exact.

Here is how it breaks out. The understatement of demand as a result of electricity price forecasts is 1.2 quads; i.e., a 1.2 quad shortfall in gas demand resulted from a really favorable situation forecasted for electricity.

Electricity prices were forecast in the EIA model to grow at some .6 to .7 percent per year, in real terms, despite a recent experience of 2.6 to 3.7 percent--in that range--in the years 1972 to 1978.

For example, quantities of nuclear power by 1990 are forecast at 9.4 quads of primary input equivalent. We would question this forecast seriously. We question particularly the price forecast, but also the electricity supply forecast.

It's akin only to the EEI forecast that is now floating around review circles of some 5 percent per year growth in electricity supplies. I think those days are over. I don't think it will be any more than 2 percent. That is one of the reasons why gas demand fell short.

The second reason of the four is a 1.3 quad understatement as a result of the incremental pricing assumptions that were used. We all have our own assumptions as to what will happen with NEA incremental pricing. If we take a look at the EIA study, though, I believe they used a full Rule 2 alternate price level. We consider that to be extreme in any central case.

Rule 1 would extend incremental pricing to boilers of a certain size or greater, 300 MCF or 5 percent. The alternative fuel price level for this coming year will be high-sulfur No. 6 oil.

Parenthetically, let me point out that I'm talking in an area that I'm not sure is really concerned with the innards of the supply model, but I think we're coming back to that. It's also not clear to me whether I'm getting across when I speak about Rule 2, Rule 1, phase 2, alternate fuel price levels, and that kind of thing, and incremental pricing.

Frankly, the whole thing ought to be repealed; that is; Title 2 of NGPA. It's one of the worst laws we've got. It could, however, bring on the kinds of things that EIA did assume. Their assumption of severe implementation of incremental pricing resulted in understatement of gas demand by 1.3 quads.

The third factor is an understatement of 1.7 quads, as a result of an excessively fast rate of back-out of boiler fuels. AGA conducted a detailed analysis two years ago that got us into a lot of hot water with the Department of Energy. We forecast that, as a result of the Clean Air Act constraints on coal use in this country, coal use will not go beyond 850 million tons per year by the year 1985.

That's a pretty dire forecast. By contrast, the EIA forecast is over a billion tons per year by 1985. The National Coal Association's forecast is about 1.2 billion tons per year. The heaviest of them all, NEP-1, forecasted 1.3 billion tons per year by 1985.

Again, ours was 0.85 billion tons per year. Our nation's consumption rate is presently about 700 million tons per year. It's been roughly static for about 3 years, now. AGA's analysis detailed the Clean Air Act in terms of its nonattainment and prevention of significant deterioration provisions.

I think if these are taken into consideration successfully the fuel use constraints in the EIA demand model need to be reexamined sharply. We feel that this alone resulted in a gas demand shortfall of 1.7 quads.

Finally, consider the exclusion of curtailed loads. There is some question as to whether this really occurred in EIA's analysis. We believe it did. In other words, a 2.0 shortfall in gas demand in the EIA midterm demand model resulted from the exclusion of previously curtailed loads in the equation for the current years.

Let me just review the situation briefly. As you all know, gas use in this country (industrial) fell by some 3.2 to 3.5 quads over the past 7 years as a result of curtailments because of gas supply constraints. About 2 to 2.1 quads of that shortfall went directly to oil use. The rest went to other fuels--coal, electricity--or disappeared altogether. Whether or not we should consider that 2 quads or million barrels a year oil use in industry today as eligible for gas demand is really the question that I'm getting at.

Evidently, it's not clear that EIA did. We think it's eligible. In fact, .8 quads of it has already come back on to the gas system since the beginning of this year. That is, gas use in U.S. industry has increased by .8 quads through increased oil offsets on the part of the gas utility industry since the beginning of this year. (I'm using quads and Tfcs interchangeably, by the way.)

So, we add up the numbers and it comes to a 6.2 quad shortfall. Whether this is the exact amount or not that will come out of the re-evaluation, I don't know. I'm not sure it's really important. I think it _is_ important, however, to note that the EIA's gas demand analysis understated potential gas demand very considerably and very seriously as a result of the kinds of assumptions that were used.

Now, what effect did this have on gas supply? Well, it appeared to cut off gas supply beyond the very good conventional forecast. In other words, supplemental supplies of gas were just kind of omitted from consideration. Very small quantities of supplementals entered in, compared to what could be available by the year 2000. EIA's forecast is telling us that the demand pull won't be there to bring on new supplementals but, in reality, will that happen? I'm not sure. If, in fact, gas demand will not be there, it's questionable whether, in fact, the supplementals will be cut short. It is more likely that some supplementals and some natural gas would be cut short.

So, I really question whether, in fact, the process of balancing that we heard praised, here, is really internally consistent in this respect. Let me just give my recommendations and I'm done. Then we can all fight it out.

(Laughter.)

The recommendations I have are four: First, the marketplace model has got to be repaired to reflect emerging U.S. policy on natural and supplemental gas. The policy on natural gas is now one of consideration of gas as an important fuel in the energy mix in this country from the present time onward.

This is not so much a result of natural gas being all that good or great. It's more a result of a lot of serious problems with some other fuels. I won't go into all that, except to quote my boss, Bud Lawrence, in discussing the problems of other fuels:

He says--in his Oklahoma accent--"We all are believers in nuclear power, but, let's face it boys, they've got a plumbing problem."

(Laughter.)

I am personally a real advocate of nuclear power. I don't share the extreme view that we ought to stop nuclear plants. John Kemeny was a professor of mine at Dartmouth. I believe him; I think that nuclear power has got to go on in this country.

However, gas supply policy has got to be, and is, being re-evaluated. I don't think that this kind of re-evaluation is really inherent in EIA's model. It has not been reflected.

For example, we have already discussed the kinds of restraints on coal use that need to be included in the model. They can be quantified, and they should be. EIA shies away from quantifying environmental restraints, but that's just not reasonable any longer. AGA would be glad to discuss approaches to this.

The second recommendation I have is to take a hard look at world gas and oil supply. This is in the interests of a more realistic consideration of the prospects for supplemental gas supplies in this country.

In the EIA model, LNG is treated as just a big question mark. EIA ought to take the lead in a real, genuine, detailed evaluation of world gas and oil supply in an effort to better understand the prospects for imported gas into this country, and to evaluate the world oil situation on a more realistic vein. That is my second recommendation.

The third is in the unconventional gas area. We've had better success at AGA in forecasting supplies of unconventional gas by considering it to be a discrete separable modeling problem, not just kind of an enhanced recovery adjunct to the natural gas supply model.

I think this is a different situation. Unconventional gas includes some things that really are natural gas. Methane, I think, can be treated in the same way, although the resource base is separate. They ought to be modeled separately from the start with their own resource base; their own constraints; their own technology. In addition to that, conventional gas includes some renewable sources of methane. I don't see this reflected anywhere in the EIA model.

Finally, the issue of synthetic fuels. I just throw that open, and perhaps there can be developed a way to internalize a more realistic perspective of this, other than trying to devise some sort of price balance.

We've really got to go beyond that, I think, and integrate some other kinds of needs for synthetic fuels, such as national security.

Therefore, I'm asking you to do all the kinds of things I can't afford to do . . . maybe that I'm not even allowed to do.

(Laughter.)

I wish you luck in this effort, you know. And we are ready to help you out. Thank you very much.

DR. GASS: Thank you very much. Our last speaker on the panel is Dr. William Vogely from Penn State University. Bill, let me give this over to you.

DR. VOGELY: Thank you. I'm facing a problem that I'm not used to. Since I became an academician, every term I have a new audience who has never heard me before, and therefore I can't be accused of repeating my war stories.

I've already had one complaint that I've told my Bureau of Mines story somewhere else. It is an old story, but I'm really not Johnny Carson I only have a few stories and I have to repeat them. You may have heard what I have said before; if so, please bear with me.

I want to make a few points which are connected, but may sound disjointed. The first point is on the theoretical structure of the modeling effort of oil and gas supply. All of the models in this area are integrated models, especially the EIA set. They establish an equilibrium of supply and demand based upon a single step production function. They are not founded upon a geological occurrence model. There is good reason for this. Geologists do not know where fossil fuels come from; they do not know how they are accumulated in the earth's crust; they do not know, therefore, the size distribution and the frequency distribution of their occurrence.

If you're a geologist, you may be very mad at me because, presumably, you do know this. I point out to you that you don't. We heard today from Ed Erickson that all of the giant oil fields have been discovered. The same thing was said when we ran out of giant oil fields in Pennsylvania.

Suddenly, somebody discovered that oil occurred elsewhere than in Pennsylvania; it occurred in Texas. Then we ran out of Texas Field because we ran out of Pennsylvania type formations--until some damned fool drilled in east Texas. It just takes one more damned fool to drill somewhere and find another way that petroleum occurs. Then we'll start over again.

Even the U.S. Geological Survey recognizes this. Mr. McCullough, of the geological survey, who wrote an article on all of the estimates of ultimate petroleum resources, made a very profound statement.

He observed that they are all based upon observed behavior of human beings and, therefore, are incorrect. After all, the oil was not put there by human beings.

(Laughter.)

What is needed, theoretically, is a geological occurrence model specified from geo-sciences. Secondly, an exploration model, that is not specified on the basis of the price of the product but on the completely different set of institutional parameters and highly constrained by technology, is required.

Thirdly, another set of models, close to what we have, is needed to explain actions after petroleum is found; i.e., primary, secondary, and tertiary development for recovery. Finally, model for refining capacity and transportation complete the set.

All of these stages are really very separate and need to be separately specified and separately modeled. To collapse them to a single system driven by the equilibrium in the fuel market strikes me as being an extreme simplification. That's the first point.

The second point: a policy perspective. It seems to me that until the policymakers stop evaluating their policy decisions in terms of the impacts on the model results, sound policy will not be adopted. Decision makers should evaluate policy in terms of the impact on the viability of the process that the model is supposed to describe, not the change in the numbers. So as long as they deal in numbers, the results are going to be the kind of things that the AGA complains about. They must evaluate tax policy, not in terms of the report of a wind-fall profits tax on new exploration (because after all, we all know the new exploration is on a marginal price cost basis; and wind-fall profits have nothing to do with that; therefore, there's no impact) but on what the proposal does to the process itself.

Until they look at what a set of government policies does to the process itself, they do not have a proper evaluating procedure for policy analysis.

The third issue is the one raised by Ed Erickson on information. As he points out, the only way to get final information is to drill, ultimately. The difficulty is that all of historical information on drilling is very, very heavily biased by where the geologists told the industry to drill. Thus, the data base is biased.

One of my colleagues at Penn State has argued that if we drilled on a truly random basis we would develop, then, an information base from which one could draw conclusions. We do not now have an information base from which we can draw conclusions. This is a far out idea, but, basically, we are going to be driven there. We really ought to be drilling for information on some kind of Latin square. I don't care how big you make it, but only that way will you be able to begin to develop an information base which is truly without bias and to which you can apply all these nice, sophisticated techniques that EIA is so competent at. Maybe then, some results can be derived that make sense. My fourth point is: I am afraid that our whole society, in energy and elsewhere, has moved into an era of tyranny by numbers. I'll give you two examples.

The major stock market collapse that resulted from the Federal Reserve's mis-count in money supply is one; and, the President's request that the EIA provide weekly numbers to 300 thousand individuals across the country so they can keep a weekly tab on what is happening to the stocks of gasoline is another. We are being tyrannized by meaningless numbers.

I'm a college professor and therefore I must make a literary allusion. Ed Erickson referred to a children's book.

(Laughter.)

I happen to be a traveler and I stay at the Hilton Hotels. I find in the Hilton, along with the Bible put there by the Gideons, a paperback put there by Conrad Hilton. The title of the book is "Be My Guest," the biography of his father. There is in it, an example of the tyranny of numbers. He points out that his dad (or his grandad, I'm not sure) was one of the early users of scientific decision making. He had two plots of land that were available to him at the same cost. He did extensive soil samplings. He did all the work that one does on plots of land. He determined that the plot of land in Long Island was highly fertile; therefore, he bought it rather than the plot of land on the Battery of Manhattan. Now, that is a tyranny of numbers.

We are measuring those things which we can measure. We are assuming those things we don't know anything about. And, we are being tyrannized by the results of our calculations.

Finally, the whole structure of the modeling effort which--I guess you dropped the word "PIES," but it is essentially the same kind of structure--flows from an equilibrium of supply and demand. Then, really, the analysis flows from shifts in these curves, or changes in these curves in response to various perturbations in the system.

However, unless I misunderstood Econ 502 (I guess you don't get this in Econ 2, but you do get it in the first advanced course in micro-theory), it is conceptually impossible to draw a supply curve for any but a competitive industry. You can draw a marginal cost curve for any industry, but to assume that supply will follow that marginal cost curve assumes a competitive response. I am willing to argue that certain portions of the domestic industry are workably competitive, but I am not willing to say the same for world oil, I think, with very good reason.

Therefore, I am a little concerned at building a huge model and expending much effort based upon a conception which, intuitively, to me doesn't make any sense. So what? The economist always argues that eventually you've got to get back down to the pervasive role of cost. Perhaps we can agree that we can't get a supply curve, but, in the long run, the industry really has got to follow cost curves.

Let me give you an example of how this may mislead. Maury Adelman points out that the conventional wisdom represented by the current stated objective of the President and by the Harvard report is that we have to reduce imports to force the world price of oil down, and to increase our national security.

Mr. Adelman points out that while this may be so, the way you do it makes a great deal of difference. Precisely, if you impose an import quota and the major exporters are a monopoly, the result will be an increase in the price of oil, not a decrease. The exporters, as a monopoly, will be profit maximizing in face of a more inelastic supply curve; therefore, they will raise their price and reduce the production in response to an import quota, not the opposite.

It's very simple, very straightforward. Simply recognize that you are not dealing with a competitive market. So, with that, I will close and we can have discussion.

DR. GASS: Thank you very much, Bill. I would like to do the following, from the point of view of questions and discussions. Since someone commented it is an EIA roast, I would like the two roastees to have an opportunity to maybe make some comments based on some of the points that were made by the speakers.

(Laughter.)

So, Charles, would you like to go first?

MR. EVERETT: I think I'm going to display my true emotional character soon, rather than my cold-blooded analyst's character.

I can think of one word at this point. I'm overwhelmed. I'm overwhelmed just like I think the demand for energy information is overwhelming. I'm not really sure what the purpose is of the great many things that I do, but one of the things that I have found to be useful is that in analyzing a problem I like to modularize what I know.

I like to think of not trying even to forecast production reserve additions unless I have a demand model somewhere nearby; just the marginal cost of lifting a barrel of oil from the North Slope versus that from Saudi Arabia and Texas is only one piece of information, I really have to know a lot of other things.

Professor Vogely touched on this. As far as textbook supply curves are concerned, I had two economics courses as an engineer: E-101 and E-102. That has done okay so far, but I'm willing to be convinced otherwise. The textbook supply curve says here is a price and now let's draw a curve that generally slopes upward. It certainly slopes upward very quickly in the oil and gas sector, which we are trying to talk about today.

I don't want to branch out too much into the other areas, including demands; but, what we do in our process is try to take the best available judgment of people as well as scientists, economists, geologists, and the like and put it together in some meaningful way.

That is difficult. It is not clear that the previous remark I made about solar is really important. I think, if I had a choice at this point, I'd rather work on solar for the rest of my life than analyzing energy markets and regulations and possible policies.

The decomposition of modularity issue is important to talk about. Price elasticities of oil and gas are not very helpful. In the annual report, what we hoped to do was to point out that the elasticity of supply of, say,conventional oil and gas in the long run might be .5. What does that mean?

Well, it doesn't mean very much in the case of enhanced oil and gas recovery, because there is a lot of stuff shut in for non-economic reasons. If you do your simple arc elasticity computation on the wrong set of numbers, you get dumb results. They lead you into the next and hopefully more detailed round of debates. The comparison and contrasting of forecasts is something that I also don't know about their usefulness.

The energy modeling forum, which I hope is partially funded by EIA this year, is an exercise in trying to do that. Sometimes, it is useful and sometimes it isn't.

The overwhelming discussion of methodology in this year's report is probably good, on balance, because we're exposing what we would like to talk about. You understand the problem a little bit better.

As far as uncertainty, I think, as long as you have two people, you have two different forecasts in some regards. On the other hand, there is the lemming syndrome. Uncertainty is the biggest tool of any policy maker in Washington, D.C.

There aren't going to be many price policies that change the decline rate of the lower 48 crude oil production. There are going to be, likely, some policies which affect the rate at which wells are poked into the ground (which is true sampling without replacement), and this will give us information far beyond what the geologists can dream up on their own.

That is a theme in the National Energy Plan II. I don't view the use or abuse of any model or set of models as being dangerous. I think that is also constructive, in some way.

The EIA results, by the way, and the Fossil II results have been integrated in the National Energy Plan. We obviously don't publish Fossil II results in our publication, except possibly for comparison purposes.

A few more points and then I'm going to let Dick respond. I think there is something that is definitely missing because of terrible demand for energy information that is levied on a lot of people trying to make important decisions that affect people.

One is that models have generally been viewed as black boxes. We don't like to view them that way at all. In my mind and in my new role in EIA, I like to think of them as fairly intelligent ways of discussing the adequacy of information that we have general authority in the EIA to collect. Sometimes they don't help very much in telling us what new data to collect, because there are new laws everyday that defy the physical world that simply try to take up the economic analysis problem of some scarce resources.

Finding rates are a hard thing to talk about; also, some of the inputs and outputs of the model get mixed up. In one type of supply model a finding rate is an output; in another kind, it's an input.

On deciding upon the inputs or arrangements of inputs for a model, you have to rely on expert people. In that regard, our models are something like laboratory equipment.

One of the things I'm very keen on, and I think Dick is also, is trying to turn information about the physical world (for example, blips of soundwave reflections that show up on contour diagrams, seismic maps) into something more reduced and easier to understand. Like, is there oil and gas there?

If so, at what risk and at what cost might it be developed. I'd like to see the physical world connected with the economics.

We have a lot of work to do and I'm not sure that the cost is a real element, at this point. I think I'll be quiet now. Thank you.

DR. GASS: Dick?

DR. O'NEILL: Thank you, Saul. Yes, I would like to respond using some notes that I've taken during the course of the critiques. First of all, the question was asked, "What was the purpose of ARC or why was it important?"

I think that ERA is requiring, in some sense, utilities to use our forecasted numbers in their planning process. So, there is a use in that respect. Why is it important?

First of all, the Energy Information Administration is chartered as an independent operation. The administrator can issue reports and studies without the signature of the Secretary of Energy. The EIA was given a specific role: to be independent.

The alternative to doing something like our annual report, which is maybe a stack of volumes a foot high, is the way that Walt Dupres suggests that we do national policy analysis and national energy forecasting. That's to put four men into a room and let them do it. It is hard to figure out what they did after they come out with just a table of numbers.

At least, you have a chance of figuring out what we did. AGA has, apparently, looked closely; so has Texas. Milton Holloway's group in Texas has looked very closely at what we've done.

We have current studies under way to try to figure out how a driller gets cash to go out and punch holes in the ground; and we're not sure how the funds are acquired. Some people think they understand it; but, in addition to the drillers, we will be talking to the lenders--I think the biggest lender in the oil industry, Chase Manhattan Bank, trying to understand how they make their loans, and how they view decision making. We also have studied the infrastructure of the drilling industry, trying to understand how rigs become available to drillers.

In the area of comparisons, I spent a good portion of the last couple of weeks comparing our forecast to, among others, the CBO, the CIA, Exxon and Shell. Most recently, the CBO published a table of numbers; that is all we have. We were asked to tell why they differed from ours. The CIA published a book, not saying too much about what they did. We were asked to say why their numbers were different from our numbers. The CIA was not asked to say why theirs differed from ours. We did notice that the CIA's forecast looked terribly much like Exxon's.

(Laughter.)

It is hard to make these judgments. We have some feelings about how they were made. We have some feelings that CBO may have looked at our numbers and adjusted, what we considered weak points, upwards or downwards. We're not sure. We do have a very strong policy in EIA of making our models and methods available. We haven't done, maybe, as well as we should have in the past; but, we certainly will attempt in the future to make our models and our methods more accessible to anyone who wants them.

Let me raise a point on SPRO. One of the reasons why SPRO isn't terribly important to the model is because of the way that we look at imported oil. In MEMM, we don't have a supply curve for imported oil. We bring it in at a fixed price; SPRO can take whatever they want.

An analysis of the reduction of risk may be appropriate; but that is a different problem.

We do believe that EOR and EGR should be modeled separately, and we're headed in that direction.

I have nightmares occasionally along the lines that Bill Vogely pointed out. That is that we do our modeling of geology, basically, on history--where people think the oil and gas is based on where it has been. As Bill was telling me a little earlier, maybe natural gas is bubbling up from the center of the earth. That is not a laughing matter; it is a theory held by some geologists.

The evidence that a lot of gas is very deep may lend support to that theory. I don't think that there is anything we can do about that but run sensitivity analyses. I think that maybe we can change our geology estimation process. Have some people start drilling in random patterns to see what happens.

DR. GASS: Thank you. Anybody on the panel want to make a comment? Perhaps we can get the audience to offer some questions and comments. Anybody out in the audience?

PARTICIPANT: I have a question to Mr. Schlesinger. If I recall correctly, I might be wrong, my impression was that back in 1974 when the TERA model was used (I think there was a presentation by one of the officials) there was a lower elasticity of gas supply quoted there. I recall something like 0.2.

My questions to you is that recollection correct; and, if so, has the gas supply elasticity since then been rising in TERA?

DR. SCHLESINGER: I can try and answer that. The TERA supply model has always been low in supply elasticity. It still is lower than some other models in terms of the actual elasticity we're using, although I can't tell you the exact number.

However, I would say that, as we have been rewriting portions of it we are taking a more realistic look, I would think, as we break it out into specific categories of gas supply. Our effort is to be as aggregate as possible.

Our need is to have consistency in our own analysis program as well as in our own forecast, which really dictates a bit of a different purpose for our modeling activity than some of the others that we have discussed. Each one is oriented toward one's own real needs for a model. So ours does not need to be a very expensive, detailed, 6.8 million dollar effort. Ours comes to less than $100,000 per year.

So, we are not able to disaggregate and, hence, we are stuck with a little bit lower price elasticity.

PARTICIPANT: Yes, but the indications are very, very important. If the supply elasticity is small, then deregulation of natural gas essentially seems to place the burden on energy demand for gas in terms of letting the marketplace do the job.

If the supply elasticity is high (I recall a number of 4.2), on the other hand, it is another matter.

DR. SCHLESINGER: I don't know what the exact price elasticity number is, but I can tell you that our forecast for gas supply, with versus without the Natural Gas Policy Act, differed by some 2 Tcf in the mid 80s. These forecasts were done with a base year of 1976.

DR. ERICKSON: I would like to pick up on that in the following vein. Whatever elasticity is in TERA, I think, Ben would be the first person to acknowledge that it is wrong; and that whatever elasticity I use is wrong; and whatever elasticity EIA is using--unless there is some happy coincidence--is going to be the wrong number.

Only experience is going to let us know. It is very difficult to evaluate that experience, both from the standpoint of what Bill Vogely was saying with regard to geology and also with regard to what the Natural Gas Policy Act is going to permit us to accomplish.

One way to look at the Natural Gas Policy Act is that, in two years, the Carter Administration made more progress on Natural Gas Policy than had been made in the previous two decades. I am not a big fan of the Act, but I applaud that progress. In the decade of the 70s, the number of successful natural gas wells drilled has increased from about 4,000 wells at the beginning of the decade to over 13,000 at the end of 1978.

Successful gas wells are up nearly 15 percent in 1979, so far, over 1978. But the average finding rate, and this picks up on what Charles and Dick were saying, has plummeted dramatically. A lot of people have developed a Chicken Little syndrome with regard to that.

That is not any different than what an economist, using either Econ-101 or 102 or Bill Vogely's 502, would have predicted over the decade of the 1970s. The price for new gas has gone up by over a factor of 10 from something less than 20 cents per Mcf at the wellhead to something over $2.00, in the neighborhood of $2.50 per Mcf at the wellhead.

That means that the drilling of a lot of crummier resource stock is much more cost effective than it used to be. Nevertheless, we find ourselves in a situation where models evaluate average experience, and average experience may tell substantially less than the full story.

A man 6 feet tall may drown in a stream of average depth of 2 feet. If one collapses the 20 or so categories of gas in the Natural Gas Policy Act into 2 extremes, we may find a U-shaped distribution of drilling activity. On the one hand, drilling for very deep resource stock has expensive costs associated with very deep drilling and requires large reserve backing and high flow rates per producing well. And at the other extreme, drilling a lot of shallow crummy stock, which on a per well basis is very small resource stock, is cost effective at the intensive margin because of the higher price.

All I can say is, I do not know. Ben does not know, Charles does not know, Milt Holloway does not know. Experience is going to dictate to us on an incremental basis, a little bit at a time, more ability to evaluate that situation. In that regard, it is instructive to quote two of my favorite quotes of Mark Twain. The first is, "A man who has tried to carry a cat home by the tail has gotten an experience that is always going to be useful."

We are in a transition process to substantially higher energy price and cost levels. We are carrying that cat home by the tail, both economically, politically, and otherwise.

Mark Twain also said, "Follow the example of the newspaper. If no one else will pay you a compliment, pay yourself one."

In that regard, please allow me to call your attention to a report which I recently did and which is much shorter than the EIA report. It focuses only on natural gas. It did not cost anyplace close to $6 million, though I wish it had. The report is entitled Natural Gas Supply and Demand Under The Natural Gas Policy Act of 1978 and copies are available from the Natural

Gas Supply Association. The Report is a preliminary attempt to try and structure how we ask ourselves the questions which we must ask with regard to evaluating only the conventional side of the lower 48 natural gas supply.

It does not contain an elasticity number. What it does contain is a framework for asking questions. It does not contain an elasticity number because I do not know what the correct one is. Nor do I know anybody else who knows--at this time, before experience teaches us--what the right one is. We are groping in the dark. That groping has got to be done, unfortunately, in an essentially blindfolded fashion. In that situation, experiential sensitivity analysis is the appropriate analytical tool.

DR. GASS: Charles? A Comment?

MR. EVERETT: I have two technical comments. This is something Milt Holloway brought up about Volume III: the way the forecasts are presented in the report.

Maybe I'd better clear this one up so no one else in the room that reads the report has the same problem that we found out as time went on. That it is very difficult to just look at marginal cost curves. At first, I didn't understand what was a price path, a real price path, over time for oil and natural gas. I kept asking myself why can't I just use $3.00 a barrel forever or $10.00 a barrel forever. Why is this important?

Slowly, I began to realize that someone else was considering international markets. The fact that the cartel came into being didn't always make it plausible what was going to happen the next day.

Basically, what we have done--I think adequately in a technical way with the modifications of the oil and gas model that we picked up from industry, was try to make it respond to non-constant real price paths for the annual report because of time limitations and cost limitations.

Especially in chapters 10 and 11, there is a big distinction. The entire market equilibrium model and the international models have looked at international markets and plausible price paths. In some instances, they have even computed these price paths.

We actually analyzed different world oil pricing scenarios with a full modeling system: the whole MEM, MFFS, and Satellite models network.

We didn't have enough time, for a lot of reasons, with the oil and gas supply models to carry that into things like leasing policy, the cost of drilling a new well some time in the future and even just varying geology.

So, what we did is made some reasonable assumptions, ran the supply model and displayed those results.

Chapters 10 and 11 have two different kinds of results in them. It's important to understand. It does start to look at just marginal costs. So, there's a little bit of something for everyone. It gives you some idea how base line estimates would change if you make unreasonable demand side assumptions, like all markets clear at the same price.

The other thing is that these very simple ideas about economics turn into big models for a very good reason, sometimes. Enhanced oil and gas recovery is quite different from conventional oil and gas recovery. An example of enhanced oil and gas recovery is the western tight sands.

It may well be that taking oil and gas out of highly impermeable formations, where the gas is locked in sandstone, is like taking a loaf of bread off the shelf. You drill, you fracture, you drain. Does that fracturing affect the massive resource contained in the reservoir rock in that area substantially?

Probably not! Reservoir dynamics though, and conventional reservoir dynamics, say that cost increases and recovery eventually go to zero as the pressure in the reservoir dissipates and as the costtof raising that liquid to the surface increases.

That is why we don't think that the life cycle of some of these models is a nontrivial issue. It is very important to pick it up at the wrong end, to find out what's going to happen. Unfortunately, our legal mandate makes us bring this to a head once a year, sometimes in the face of severe cost limitations. Thank you.

DR. GASS: Thank you. Did you want to make a comment?

DR. TAKAYAMA: Yes, I will.

DR. GASS: Okay.

DR. TAKAYAMA: This is a very useful forum for exchanging views on the use of models. In a way, it is like the example Professor Vogely brought up, his very interesting view of courses like Econ-501 and 502. We usually think of these courses as the place where we really seriously discuss issues, even if there are no definite solutions. In this kind of discussion, it is not really surprising to find, as others have found in the past, that perhaps there is no supply function which is the aggregation of marginal costs curves, although we saw such functions in Econ 101 and 102. Industrial organizations and others have explained why, and I really think Dr. Vogely brought up a very good point. But, if we accept the limitations and try to model the supply function in some sense, can we then cast that structure into a model where, maybe, demand will be more readily estimable?

Charles brought up the question of the elasticity. When we talk about the elasticity, we assume that there are certain structures that generate that elasticity. We need certain information to get some kind of result.

Why are we generating these results? Are we communicating effectively? These fundamental questions raise the deeper theoretical and philosophical issues. So, let me conclude. Modeling is one way to test certain assumptions. It may be wrong, but, by generating solutions and opening them up to review by the people and the specialists, we can ask these fundamental questions.

DR. GASS: Dr. Vogely?

DR. VOGELY: I want to make two comments. One, don't misunderstand me. I am a very strong advocate in believing that the government, and everybody, should be doing much more modeling. But, the great danger is that suddenly one decides that the models tell the truth.

The model results get translated to policy models--none of your doubts get much past the Lincoln Moses, and the results are certainties when they get to Duncan; and they become absolute truths when they get to President Carter.

(Laughter.)

So, your problem is you are doing the best job you can, but certainly, the results are not the truth. To say that now we're going to require all utilities to use your forecasts in order to do their planning, to me, is the most dangerous thing in the world that could possibly happen.

So, I am a believer in the effort. I think there is a tremendous amount to do in the effort; but, at the same time, please let's not use it as the sole tool for policy making.

DR. SCHLESINGER: I'd like to support that statement. I was horrified, Dick, when I heard that ERA may issue a requirement to integrate the EIA forecast into utility planning and operations. My aversion to this doesn't grow so much out of a distaste for the EIA modeling efforts, as it does for a distaste for the idea for government to make forecasts and the rest of us to follow. That is a very scary thing. So, Bill took the words out of my mouth, and I should have been the first to jump up and scream. I did write it down, though.

(Laughter.)

I want to point out one other thing. We've been passing a lot of philosophical comments across the room; and I'll just pass one on.

Douglas Lee was a professor at Berkeley and at Iowa State. I don't know where he is now, but he goes around to conventions and professional groups and preaches the benefits of small models. I'm not so much an advocate of "small is beautiful." The gas industry has, for example, the largest distribution system of any energy transportation network in the country. It works fine and is very efficient. So small is not necessarily beautiful, but there is a school of thought that Doug Lee espouses that small-scale is really the optimal application of modeling technology. The larger models get, the more cumbersome they often get.

With so many assumptions, they finally become black boxes to most users, as Charlie and Bill pointed out. So, I would just, on the record, interject this note of caution to EIA in preparing their reports.

I know a lot of you already have, but that is my philosophical preaching of the day.

DR. GASS: Thank you. There is a comment from the audience.

PARTICIPANT: There seems to be a flavor going through here that once a forecast goes on record, it tends to be generally accepted up on the line to President Carter.

I think I violently disagree with that. As one who had a hand in making the forecast, I know from people who called me up that you tell them your assumptions. They they say: if that explains your results, I don't agree with you.

Then they say here is what we believe is true. I think that this is happening, particularly in reference to natural gas. There are quite a few differences in assumptions. It's assumptions which are making our demand forecast, not the models themselves.

The whole thing I want to make clear is when you look at the forecasts out there, the people look at them and they evaluate them. If you think that they don't evaluate them, then we really have trouble with the people we elected in this country and who are policy makers.

DR. GASS: Thank you very much.

DR. ERICKSON: I would like to make one more comment.

DR. GASS: Okay.

DR. ERICKSON: Michael Malbin at the American Enterprise Institute is in the process of writing a book (which may have already come out) about the use of numbers in the Natural Gas Policy Act debates.

I disagree with his conclusion. His conclusion is that the models did not well serve Congress. I think, however, he has a naive view--I should not say this without Michael here to defend himself--of Congress's skepticism with the numbers. I am an optimist, not only on supply, but on the political process as well.

I think that your point is right on. I think that Congress and other users are appropriately skeptical and do use the numbers with a substantial grain of salt; they do look at the assumptions and do, quite appropriately, question the whole model structure.

The models do serve political inquiry much more effectively than might otherwise be thought.

DR. GASS. Thank you. I would like to comment that DOE is sponsoring a symposium next May on validation and assessment of energy models. It will be held at the National Bureau of Standards.

There is a list of participants for this symposium at the front of the room. Actually, there are two lists. One is a supplemental list. Everybody who is on the list will get an announcement of May's symposium.

You're all invited to pick up the list of participants at the front. I'd like to thank the panel for their discussions today.

You're invited to come back at 1:00. All sessions will be here. There is one main session on energy uses.

Thank you very much. (Whereupon, at 12:05 p.m., the meeting was recessed for lunch.)

CHAPTER 7

COAL

SPEAKERS:

1. Ms. Mary Paull, Energy Information Administration
2. Mr. Jerry Eyster, Energy Information Administration
3. Dr. Richard Gordon, Pennsylvania State University
4. Mrs. Connie Holmes, National Coal Association

DR. FANARA: Good morning.

On behalf of the University of Maryland, College of Business and Management and the Department of Energy, specifically EIA, I welcome you to this coal supply discussion.

I would prefer to stick to a fairly rigid format this morning. We will have the Department of Energy representatives give their prepared remarks first, and then we will have the invited discussants follow with their prepared remarks.

At that point, we will give each speaker a few minutes for rebuttal or points of correction. Then we will throw the panel discussion open for questions from the audience.

Our speakers today are, on my far right, Mr. Jerry Eyster, former director of the Coal and Electric Power Analysis Division at the Department of Energy. Next to him, Mrs. Connie Holmes, vice president of the economics group for the National Coal Association.

On my far left is Ms. Mary Paull, who is Operations Research analyst for the Coal and Electric Power Division at the Department of Energy.

And, next to me on my left is Dr. Richard Gordon of Pennsylvania State University, who is Professor of Mineral Economics.

What we will do at this point is have the prepared remarks from the first Department of Energy representative, Ms. Mary Paull.

MS. PAULL: Good morning.

I would like to take this time to review the EIA 1978 coal projections and present some of the main factors which influence the results.

EIA uses the supply curve segment of the national coal model called RAMC, the Resource and Mine Costing submodel, to generate supply curves which are, in turn, aggregated to specific MEFS regions and input to the MEFS model, the midterm energy forecasting system.

First slide, please.

(Refer to Figure 7.1)

Some of the supply curve components are as follows: In the national coal model, there are 30 regions, which are aggregated in the MEFS system to 12. There are 40 coal types in the national coal model, which are aggregated to 11 in MEFS.

In the existing capacity component, there are large mines and small mines. New capacity is based on the Bureau of Mines' demonstrated reserve base; reserves are allocated to model mine types; minimum acceptable selling prices are estimated for each minemodel type; and, upper bounds of new mine capacity for each region are based upon planned mine openings.

In the coal washing component, basic washing is assumed for all bituminous coals and deep cleaning for premium coal only--to lower the ash and sulfur content.

Slide 2, please.

(Refer to Figure 7.2)

Key variables and assumptions in coal supply are as follows: Productivity is constant for a given set of seam conditions. New mine life is assumed to be 30 years. Existing mine life in the east is 20 years; and in the west, it is 30 years.

Mine reclamation costs are included. Severance taxes vary by state based on the current law. Reserves are the EIA demonstrated reserve base which excludes reserves for which the heat and sulfur contents are unknown.

Next slide.

(Refer to Figure 7.3)

Supply Curve Components

	NCM	MEFS
• Regions	30	12
• Coal Types	40	11
• Existing Capacity		
• New Capacity		
• Coal Washing		

Figure 7.1

KEY VARIABLES AND ASSUMPTIONS

COAL SUPPLY

• PRODUCTIVITY	CONSTANT FOR A GIVEN SET OF SEAM CONDITIONS
• NEW MINE LIFE	30 YEARS
• EXISTING MINE LIFE	EAST--20 YEARS, WEST--30 YEARS
• MINE RECLAMATION COSTS	INCLUDED
• SEVERANCE TAXES	VARY BY STATE--BASED ON CURRENT LAWS
• RESERVES	EIA DEMONSTRATED RESERVE BASE

Figure 7.2

MIDTERM UNCERTAINTIES

- COAL RESOURCES
- LABOR AND CAPITAL EQUIPMENT INPUTS
- DEMAND PROJECTIONS
- INDIRECT FACTORS

Figure 7.3

Some of the mid-term uncertainties are as follows: For coal resources, we have incomplete knowledge about the size, geological conditions and quality of the coal reserves, as well as their availability for mining.

Labor and capital equipment uncertainties include future availability, cost and productivity of labor and capital equipment.

The demand uncertainties affecting coal production and prices include the future level of electricity demand, the amount of nuclear capacity, the ability of utilities to replace existing oil-fired plants with new coal-fired units and imported oil prices.

Some of the indirect factors include transportation costs, socio-economic limits on the expansion of coal production in the western U.S., and government policies, especially those relating to environment protection.

Also, other uncertainties stem from pending federal initiatives, including the implementing provisions of such acts as the Surface Mining Control and Reclamation Act, the Federal Coal Management Program, and the Mine Safety and Health Act.

Next slide, please.

(Refer to Figure 7.4)

In our projections, we show that the electric utility and industry sector are responsible for the largest increase in consumption. The electric utility sector increases because of the growth of electricity and the replacement of oil and gas-fired power plants with coal-fired plants.

The new coal-fired plants, including the capital costs, are cheaper to operate than to sustain the oil and gas-fired plants.

This will be discussed further in the electric utilities section later this morning.

COAL CONSUMPTION BY END-USE SECTOR: PROJECTIONS, SERIES C, 1985-1995

(MILLION TONS)

SECTOR	1977	PROJECTIONS 1985	1990	1995
ELECTRIC UTILITY	476	733	1,066	1,377
INDUSTRIAL/RETAIL	67	128	200	307
SYNTHETICS	0	13	28	131
DOMESTIC COKING	77	86	91	96
TOTAL DOMESTIC CONSUMPTION	620	960	1,385	1,911
NET EXPORTS	52	74	81	89
CHANGE IN STOCKS	19	-1	-1	-1
TOTAL PRODUCTION	691	1,033	1,465	1,999

Figure 7.4

The industrial sector increases due to the power plant and industrial Fuel Use Act being implemented with the assumption that there would be few exemptions.

In both cases, the price of coal is an important factor.

Next slide.

(Refer to Figure 7.5)

In looking at the coal price projections, we see that they remain fairly constant from 1985 to 1995, with only a slight increase. The world oil price for the same period increases from $2.58 per million Btu in 1985 to $4.03 per million Btu in 1995.

As you can see, the price of coal does not follow the price of oil.

Next slide, please.

(Refer to Figure 7.6)

Where is all the coal coming from? In this slide, you can see the projections for the mid-case scenario. We see that the largest increase is in the west with the greatest increase in that area coming in the Great Plains.

This can be attributed to: the low price of coal; the fact that it is the preferred or low sulfur coal; and, because there is a market in the west, particularly the Southwest.

In addition, we see a sizable increase in the Midwest and Central West production. This occurs because of the medium sulfur reserves which are cheap to mine and, therefore, displaces the Appalachia coal.

The gulf region also increases in 1985 and then levels off, due to the fact that we run out of Texas lignite in our reserve base.

Thank you.

Delivered Coal Prices to the Electric Utility Sector: Projections, Series C, 1985-1995

(1978 Dollars Per Million BTU)

Demand Region	1985	1990	1995
New England	2.05	2.20	2.35
New York/New Jersey	1.92	2.06	2.21
Middle Atlantic	1.79	1.93	2.08
South Atlantic	1.89	2.02	2.14
Midwest	1.64	1.76	1.88
Southwest	1.72	1.80	1.91
Central	1.56	1.65	1.76
North Central	1.16	1.16	1.27
West	1.96	2.01	2.25
Northwest	1.87	1.87	1.98
National	1.74	1.84	1.96
World Oil Price	2.58	3.18	4.03

Figure 7.5

Coal Production by Region: Projections, Series C, 1985-1995

(Million Tons)

Region	1977	Projections 1985	1990	1995
Northern Appalachia	174	176	247	320
Central and Southern Appalachia	220	267	237	228
Midwest and Central West	148	235	301	393
East	542	677	786	942
Gulf	16	70	72	72
Great Plains	86	224	536	881
Rest of West	48	62	71	103
West	150	357	678	1,056
National	691	1,033	1,465	1,999

Figure 7.6

MR. FANARA: Thank you, Mary.

Our next speaker will be Dr. Richard Gordon, Professor of Mineral Economics at Pennsylvania State University.

DR. GORDON: Whenever I hear the standard joke about the inability of college professors to talk for less than the length of a class period, I recall that, if it were true, Penn State professors would be an especial hazard since we have 75 minute classes. However, I will try to disprove the joke.

I was partially disarmed by the candor of the EIA representative from making some of the criticisms I prepared last night. I have become increasingly ambivalent about how to appraise the shape of coal supply analysis in what I am accustomed to call PIES but now is apparently MEMM.

The coal analysis does happen to be much better than that for most other fuels but much improvement is still needed. However, I am increasingly less certain about the appropriate balance between greater sensitivity analysis with the existing framework and efforts at fundamental redesign of the model.

Certainly, the argument that redesign is desirable is easily made.

Anybody who has looked at how all those models were put together knows that they were built on an extremely fragile basis from quite imperfect material.

First, the Bureau of Mines, in a rather mindless fashion, put together its demonstrated reserve base, the meaning of which for coal supply analysis is clear to absolutely no one. The Bureau did not use an economic approach in defining what constituted a demonstrated reserve base.

The Bureau did not make things any better by including in the reserve base things that its own data said were not actually recoverable. In particular, before the official demonstrated reserve base data came out, the Bureau of Mines put out a little report on surface mine reserves. In this earlier report, it is noted that the basic reserves, which turn out to be the same thing as the demonstrated reserve base, contain a substantial element that for one reason or another, such as being located under rivers and highways and cities, would be unlikely to be recoverable. Thus the reserve base clearly is not a measure of economically available coal.

As a matter of fact, adjustment factors are in the national coal model and the MEMM coal analysis to take care of this. However, there's a great deal of ad hockery involved in these adjustments.

The other side of the analysis that has been disturbing is the necessity to build upon the rather casually constructed models of coal mine costing. A conscientious group of Bureau of Mines analysts tried to provide what were avowedly tentative indicators of the behavior of coal mining costs. However, the effort was grossly underfunded and presented quite preliminary figures.

Thus, the analysts' model development took resource data of questionable accuracy, base mine cost numbers of even more questionable accuracy, and finally, a theory of how costs vary with mining conditions of still worse accuracy and have been trying to build as well as they can on all this.

The approach used by EIA is not the only one but all of them leave a great deal to be desired. They constitute imaginative use of the data. But, there is only so much that you can do with one's imagination.

The moral of all this is that somebody, namely EIA, ought to be paying more attention to checking on how much all of this matters and on the extent to which one can improve this.

I believe you have some contracts out in this area, Jerry.

MR. EYSTER: I can speak to that later.

DR. GORDON: Good! I understand that progress is occurring. At the same time, the Electric Power Research Institute is putting its input into trying to improve things.

However, I am also not sure that we are giving enough attention to other problems in coal market analysis. In particular, given all the uncertainties to which Mary referred, are we running the model with sufficient daring to determine how sensitive the results are, not just to modest changes in assumptions, but to really substantial ones?

It is my own opinion that FEA in the past, now EIA, and, for that matter, most other coal forecasters have been unduly conservative in most of the work.

EIA analysts have undertaken a few such sensitivity analyses. However, the number has been too few and, too often, too little is done with them. Thus, a very interesting study of a nuclear moratorium was made for the 1978 report but only a brief discussion was provided and that was in the nuclear power chapter.

It would be interesting to see more things of this nature. I could mention things that could easily be done without upsetting anybody dealing with alternative views of what the state of the railroad network in the United States might be, particularly considering some kind of worst case estimates.

Secondly, some worst case estimates could be made on productivity and labor costs in coal mining.

There are a whole host of other things with which you ought to deal, and here, in the hope of provoking some discussion, I'm going to make a charge to see what kind of reaction I get.

Looking at the EIA, and before them the FEA forecasts, I have a feeling that, in a certain sense, they have been overly political.

Let me be careful about this. The analysis is always analytically sound and integrity on this score needs no protection.

There is some question in my mind whether you have been willing enough to consider the question: Are the policy-makers who are feeding us inputs about the consequences of their policies being overly optimistic? And what would happen if they're dead wrong by a substantial number of orders of magnitude?

It was not in the midterm forecasting area, but in the studies of implementation of the Clean Air amendment, that we went through an exercise which to my mind was in many ways something of a charade in that at no point did EPA allow ICF, in doing the analysis, to depart from EPA-imposed assumptions on what stack gas scrubber performance and cost would be.

The only departure from that was an acquiescence on the part of DOE and EPA to allow the running of a case requested by an environmental group that made the extraordinary assumption that scrubbers were cheaper and more reliable than EPA was arguing.

Since I make it a practice to look at the Pepco reports about what real scrubbers do, that EPA secures and seems to ignore, I would have thought it would have been appropriate, in this exercise and by extension in the work EIA does in its general modeling, to look at the consequences of scrubbers that perform not in the way that model scrubbers assumed in EIA, DOE, EPA analyses performed, but more like the scrubbers that are actually out there.

Similarly, it might be of considerable interest to see what would happen if various other federal policies had more serious effects than is assumed by their advocates.

These include regulatory policy with coal surface mine regulation and coal leasing delays being my favorite candidates.

On the opposite side, there has been this tendency to accept fairly optimistic assumptions about synthetic fuels and about the ability to develop industrial markets for coal.

So there are lots of sensitivity tests that have not been made. I don't know whether it's part of a general timidity about shocking the system and making the people even more aware of the enormous uncertainties involved, or whether it is because in these particular cases you feel in some sense or other consciously or unconsciously constrained by the political storm this might cause.

I hope it's the former and not the latter. Thus my complaints are that not enough sensitivity analyses are undertaken and there is not enough concern about the general quality of the basic coal supply model itself.

Which of the two is more important is hard to say, and I vacillate. For many years, I was a great enthusiast of "let's mount a significant effort to improve the basic coal supply model." This may be described as developing a better model of what geological factors do to influence the supply of coal.

I don't think that I would back away from that, except that, in retrospect, I would tone down my enthusiasm in the sense that I would not think that it is a multi-million dollar effort that ought to be mounted.

Let us say that hundreds of thousands of dollars could fruitfully be devoted to seeing what better work can be done.

The sensitivity analysis is very easy to undertake as long as you are willing to make the effort to make all the computer runs. And, I have discovered that the one thing that EIA is not timid about is making computer runs.

Nevertheless, the sensitivity analysis problem is one you can and should tackle right away. Moreover, the effort should be extensive. Particular attention should be given my suspicion that the efforts of such changes in assumptions will tend to swamp any improvements in the basic model as far as affecting the outcome.

In other words, we are living, unfortunately, in an anything-can-happen world and while EIA has made a significant contribution to pointing out the range of uncertainties, the range is probably even wider than you have suggested.

Thank you.

MR. FANARA: Thank you.

Our next speaker will be Mrs. Connie Holmes.

MRS. HOLMES: Thank you. Before starting, I'd like to say that we just about second your comments, Dr. Gordon.

First of all, we'd like to thank you for asking the National Coal Association to participate in this session. We think that the Energy Information Administration's Annual Report is a very widely distributed document. It is used and it really is, we believe, by both government and private industry alike, at least as partial input for a possible policy decision.

DR. GORDON: That's what I'm laughing at.

MRS. HOLMES: I know it shouldn't be, but it is. So we do think it is in everybody's interest to make sure that the information included in the publication and the data upon which you are making your forecasts and the models that you use are absolutely as timely and accurate, if you will, as possible.

And, we think that it's very important to review the assumptions underlying the forecasts and to make sure that these assumptions and the models reflect, again, in as much as possible, real world assumptions and expectations.

I'm going to just really limit my comments to the short-and midterm coal supply demand forecasts published in the Volume 3, as I was asked to do. But, the National Coal Association has a reputation for always criticizing everything. And that we do!

Also, we really would like to take this opportunity to, in a sense, commend the EIA for the job that you've done in putting together this annual report.

It has got a lot of problems and it has a lot of drawbacks. And sometimes it's misused. Dr. Gordon has pointed out some of the drawbacks to the coal section and to the coal supply analysis, but it has still come a long way from two years ago, when EIA was formed.

We can now use the report. If you really dig into the report, there's a lot of useful information there. I will be frank with you and say that I use less of the coal statistics and less of the coal forecasts.

And, I think I can say this for some other companies in our industry: I use the information on the other sectors as inputs to our own model. I have a feeling that possibly we're making the same mistake there because I'm sure that there are the same problems, you know, inherent in using those numbers as are inherent in using the coal numbers.

But we do it anyway, inasumch as it's worth.

Jerry asked me to give you a comparison of the EIA coal forecast and the coal forecast that's released by the National Coal Association and to indicate any types of problems that we have with your estimates.

First of all, in the short run, our coal supply demand forecast and your coal short-run supply forecast match very, very well in most sectors. Your mid-range, your mid-mid-short-term forecast for electrical utility use, for example, in 1979 is 528 million tons.

The current forecast that you have out for 1980 for utility use is 554 million. Our National Coal Association's revised 1979 forecast for utility use is 525. Very close. And, in 1980, we are looking at about 552 million tons. Again, very, very close.

Of course, the basic reason that I think we are this close is the fact that we're working with the same basic assumptions. Namely, that utility coal consumption follows the expected additions of new coal capacity. And, it doesn't fluctuate greatly because these plants are being base-loaded.

Furthermore, as you have pointed out and we have pointed out, utilities operate in, as much as possible, on a loaded cost basis. And so coal, if available, will be the first fuel used. And those coal plants will have a high rate of utilization.

I think it was pointed out very well this year in the high rate of utilization that we have seen in Midwestern coal-fired plants.

For example, we have to totally disagree, however, with some of the statements that your short-term forecast makes about coking coal consumption because we've looked at this very closely, prior to the issuance of Father Hogan's coking coal report, I might add.

In the short term, coking coal consumption is related to coal capacity. It's not related to steel production. While your 1979 mid-mid-estimate of coking coal consumption, 76 million tons, is definitely achievable--in fact, it's our forecast--we think after a real hard look at this area that anything higher would be extremely difficult.

Specifically, we believe that the 1980 theories that you have published, which show mid-demand estimates of 81 million tons and high demand estimates of 86 million tons, are just really very unrealistic.

We don't think that you have given adequate consideration to the very real coke capacity limitation that does exist in this country.

Now, the annual report does make a brief mention of this factor. And, you make mention of the factor that you adjusted your numbers downward.

I know that the numbers that came out of your short-term coal model were much higher. But, we do not believe that they have been adjusted downward sufficiently.

Also, as a minor point, in your back-up report (the energy supply and demand in the short term) you don't reference the problems with the coking coal situation at all, at least that I could find.

We would like to also just make very brief mention of your short-term export numbers and the fact that they do seem to be fairly weak. Frankly, most export forecast numbers are fairly weak, but we are not getting more information, which we, of course, would be willing to share with any of you, that we believe will help firm up these numbers.

I would also like to add that your own Division of International Affairs is becoming much more heavily involved in the export area and probably could give you some very good input.

But, parenthetically, I would like to add that your 1979 mid-mid demand projections are going to come as close as anybody's, including our own. We have had the benefit of having revised our forecast twice since the beginning of the year, as we do revise it quarterly.

And, I hate to say this, but I don't mind admitting that the forecast that we made in December for 1979 was probably one of the worst forecasts that we've ever made. Of course, we have since revised it into what I feel is a fairly accurate indication of what's happening this year. But your short-term forecast was much more on target than our original one was.

With respect to the midterm projections, as Mary has pointed out, there are many, many uncertainties inherent in that midterm forecast. Many more, of course, than in the short-term forecast.

We believe that, at least through 1990, the supply capability margin will continue to exceed demand levels. But, after 1990, several factors could come into play in both the demand and production side to bring a closer balance between the supply and demand picture, if you will. Possibly, we can see a certain set of circumstances bringing the situation into an excess demand situation, at least on a temporary basis.

To look at the consumption forecast first, I will explain to you, as many of you already know, that the National Coal Association does not issue a 1985 or 1990 or 1995 forecast officially.

However, unofficially, we do, of course, make estimates in most areas. And, in most of the categories, our estimates fall at least within the ranges of the A through E scenarios that you have included in the annual report. At least 1985 estimates do.

We are a little more pessimistic on the utility side than you are in 1990 or 1995. Frankly, I think there is one underlying reason. That is the fact that we're much less confident of the positive effects of the Fuel Use Act than you are.

In your report, you think that FUA is going to work and we're not altogether convinced that it is.

But, of course, there are other factors that could act the other way and could act to increase our demand projections. And, specifically, I'm referring to the proposed 50 percent utility oil back-up program, especially if some way is found that it can be combined with gas to have a 50 percent oil and gas back-out, which, in our opinion, is about the only realistic way to get anything done.

If you can get a realistic program through Congress and, finally, before 1990 we can get a realistic set of regulations and decide that the utilities actually will comply, we do not believe that regulation is the way to go. We never have believed that regulation in that direction is the way to go.

But, if such a program does come forth from the Congress and it appears as though one might, we hope and will work to make it as realistic as possible. Hopefully, such a program as well as very rapidly changing coal-oil price ratios are going to make a great deal of difference in the coal demand in the future.

When we're looking at the industrial retail sector, we definitely are not as optimistic as the EIA forecast. Again, I think it's because of our interpretation of the Fuel Use Act versus your interpretation of the Fuel Use Act and the differing assumptions that we have concerning the fact that either utilities or industries don't always act in their own best economic interests in the short run.

In other words, when that curve crosses and when it becomes more economical to build a new coal-fired plant rather than to continue to burn the oil and gas, they don't always do it.

We believe in the industrial sector, at least, that we're going to gain more market-wise, as the relative coal-oil price ratios become even more distorted and unrealistic--well, more distorted than they are now. And, as new marketing techniques that are being developed by the coal companies to serve the very specialized needs of the industrial customer are being developed and recognized, we think that the increased consumption that we will see eventually in the industrial area will be more of a result of those factors than the results of the Fuel Use Act.

The consumption forecasts that we just absolutely totally disagree on are the synthetic fuel forecasts that you have put out. Your 1985 forecast shows 13 million tons will be used for synthetic fuels in 1985. I don't know where you got the number, but that's what it is, anyway.

I asked our experts in the field at our bituminous coal research labs and some other experts in our organization that are very familiar with the synthetic fuels industry, at least the potential synthetic fuels industry. We do keep an unofficial running survey of the project, the status of projects, et cetera.

Our last unofficial estimates that we compiled just last week show that, by 1985, we'll be lucky to use 2 million tons in the development of synthetic fuels. And, it's just about all going to be demonstration.

In 1990, your forecast ranges from 28 to 46 million and, again, we think you're just way, way too high. We are not going to argue the potential of the market, but we definitely would argue the timing that the market will develop for synthetic fuels.

As you have pointed out within your report and again this morning, there are many possible constraints. But, we think that there are many possible opportunities too, which could change the outlook for coal consumption either way.

On the constraint side, and especially for the short run, we are looking at the Clean Air Act as amended and the regulations promulgated under that act as the single biggest factor affecting the market of coal.

Of course, there are some Congressmen and Senators now that would like to amend the Clean Air Act in different ways. Waxman is holding hearings on this next week. Should that act be amended, it could have a definite--depending on the way that it is amended, of course--outlook on coal in utilities and industrial use.

As I said, we also question the enforcement in the Fuel Use Act and its effect. Other things that are going to effect the outlook for coal especially are the availability and price of natural gas and oil.

Just as a sidelight, we have recently completed an analysis of our last steam electric plant. Factors included new coal-fired and nuclear plants coming on line, their expected dates of completion, whether or not they're under construction, et cetera. We have seen a real slip in the coal-fired plants in the Southwest area, which I hope is going to show up in your next forecast. But, it is a definite happening in 1985.

You will see far less coal consumption in the Texas, Oklahoma area than you anticipated, or even we were anticipating a year to 18 months ago. We think that this is a result of two things. The forecast of the use of natural gas in that area has been increased by almost 50 percent in the last six months. And, coal-fired plants have been delayed accordingly. That is something that really affects the market there.

On the positive side, we look at the development of synfuels, of course. And, as I said, we're not quite as optimistic as you are. Still, that could have a positive effect on the market in the mid- to late 1990s. On the more immediate term, we're looking at a very strong steam coal export market, which I certainly would not have anticipated even six months ago.

With respect to coal supply and, again, with your coal supply models, I would think that we would just have to echo Dr. Gordon's comments on the coal model that you used. It does have some problems and it has to be used, of course, very carefully.

As I mentioned, we know that supply capability does exceed the demand. We think that supply or coal production capability will be more than adequate to meet demand levels, at least through 1990 or the next decade.

Our projections do differ from yours slightly, primarily because our demand projections differ. But our biggest differences, of course, are in the east-west split. We do not, for many reasons, project or forecast our production on anything but an east-west split.

Frankly, the primary reason we don't is our lawyers won't let us. They tell us it is for anti-trust reasons and I don't know. I'm not a lawyer and I don't quite understand all of these anti-trust matters. But, they do tell us that we have to be very careful about projecting market share and projecting shares of production and, therefore, we can only split east-west. So that's all we do.

But, our split is different than yours. The primary difference in the west, of course, is due to demand. Your synthetic fuels numbers and ours are much lower. Also, I think we have some differences because of the assumptions that we have made concerning the new source performance standards that were promulgated by EPA last May.

I think we split ours just a little bit differently than you do and probably put a slight bit more of the market back in the Appalachian area and take it out of the west.

The main difference that your model and that all models have, whether it be DRI's or whoever's, is in the area of the Midwestern coal production. I'm sure that you are all very aware of the sharp differences of opinion in the Illinois basic and future coal production levels there.

We do have a couple of suggestions, of course, that we would like to make. We couldn't leave without that.

First of all, on the data side, we have to reiterate, underline, and underscore all of the remarks that Dr. Gordon made about the coal reserves. The data is simply just not any good. And, it's not being used, we believe, in the correct manner.

I'm not going to dwell on that, since I know that you heard it many times. And, I know that Jerry is going to talk a little bit, I hope, about the work you're going to do to improve those data reserve numbers.

The second area that we have a sincere concern in with respect to data, and again we do have to commend the EIA because you are working on it, is in the area of industrial coal consumption data. That area is also very weak, and you are projecting basing some very important numbers on the basis of some really crummy data.

As I said, Chuck Heath is trying to upgrade these numbers and trying to get a better handle on the industrial consumption numbers. But, they are used as if they are real, and they are used as if they are correct and they aren't.

In your report, we think that it would be a big help to the user and would indicate much more concern if you would spell out the limitations of some of the base data that you have used to generate your consumption forecasts and your production forecasts. While we're on data, and I think Jerry's going to talk about this, too, the production data sometimes is a little weak as well.

We have had a lot of discussions about this. But, weakness in the input data means weakness in your output.

With respect to the timeliness of the report and with the realization that this is very important but very difficult at the same time, I have been asked by many of our members to reiterate to you that, because the energy picture is changing very rapidly and although we do recognize that the lead times to prepare your report are very long, as a result, your annual report and your forecasts are out of date when you issue them. That happens!

Our forecast is out of date two days after it's issued. We recognize this problem.

The report receives so much attention and it does, but most times it receives attention without mentioning that most of the assumptions and the legislative assumptions that are included and underlie this report are anywhere from four to six months old.

You see a piece in a paper or an article in Coal Week or Coal Outlook and they're nice numbers, fine. But, you don't get any indication that they really are based on assumptions that are, in this very rapidly changing world, almost out of date.

We have noticed, too, in our experience with the use of this report, and we do run across probably as many users as you do, that most people who are not terribly knowledgeable use these reports as if they were gospel and golden for the year in which they are current.

So, we would really like to see you make mention somewhere in the report of the fact that these numbers do change very rapidly. And, because the report is so widely used, we would recommend that when there are things that really throw the system out of equilibrium, for example, these very tremendous increases in oil prices that we have seen or the Three Mile Island nuclear moratorium, issue an update and sent it to all your users.

I know that's hard. I know that will be very difficult to do.

But, back on the sensitivity analysis again, if you would just do a short run on your computer under series C projections, you could send it out and give us an indication of how these events are affecting at least your series C projections.

Finally, for all of our members I think this is probably the most important suggestion that we can make. That is the fact that there is a very definite need to bridge the gap between the forecasts that are published and derived from your models and the real world.

We are concerned that, in most cases, your forecasts do not perceive the real world happenings. You're working on least cost assumptions; and utilities and industrial plants don't always operate under least cost. They have long-term contracts that might not always be the least cost for them.

They tend to make decisions based on government regulation and not on least cost.

For example, we have Utah coal coming east because a particular utility plant is built for high Btu coal. And, rather than utilize the plant, they are bringing that coal to the east. That is not the least cost option for them.

But we are very concerned that these types of things are not adequately reflected in either your forecast or in your write-up. It is not completely explained that there is some problem in bridging the gap between the forecast and the real world.

So, we would like to suggest to you that possibly we could help you out in this case. We would like to suggest an industry review of the assumptions underlying the forecast and the industry data, most especially that mining cost data that you use and which Dr. Gordon has mentioned and with which we have had many problems.

So, as I have talked to Jerry before, we would suggest that you consider calling in some of the industry experts. I don't mean the presidents of the companies. I mean the working people in the companies, the people who can tell you what the mining costs are and who can tell you where your data is wrong and can help you correct it.

Thank you very much.

MR. FANARA: Thank you, Mrs. Holmes.

At this point, we would entertain any responses from the Department of Energy.

MR. EYSTER: Just a few comments in response to what has been said earlier. The modeling of government regulations is a very basic issue as far as EIA forecasts go. It goes to Dr. Gordon's point about EIA's forecast being a political forecast, overly political.

We are constrained in the sense that we try not to lead policy. We try not to lead the regulatory process or undercut the regulatory process.

Therefore, EIA is in a very difficult position as to what we assume when we analyze a new piece of legislation, or when we deal with the enforcement of a piece of legislation.

In the case of coal conversion or PIFUA, if we assume that the law is not going to be enforced fully that assumption has significant implications.

What should we do if we know that a certain law is scheduled to expire by such and such a date, but, in our best judgment, believe that Congress will not let the law expire, and will do something to continue it? Can we really assume that the law will be extended?

In another situation, we know that environmental controls in the past have been tightening, yet what is on the books really specifies only a certain level. If we assume no further tightening of environmental regulations in the future, there are some very real implications there.

These problems of what we assume as policy have been the subject of discussion for many hours of people's time in Applied Analysis. How should Applied Analysis handle the problem of interpreting legislative regulations and enforcement?

I think a lot of the discussion that we heard today focuses very heavily on this. The discussion of the industrial coal consumption numbers is going to the heart of that issue. In essence, the difference of opinion results from one's assumption concerning the effectiveness of PIFUA.

I do not think that anyone is saying that there is going to be less coal consumed in the industrial sector. What we are differing on is how fast the market is going to grow, and how much of the industrial market is going to get captured by coal. These differences basically depend upon interpretation of the success of PIFUA.

In the electric utility area, we have a slightly different problem, which is an interpretation of utility behavior. We're going to get into that later this morning in the electric utilities discussion. So I'll not pursue that now. However, there are two important aspects to keep in mind. First is the growth in demand and second is the replacing of existing oil-fired capacity with new coal-fired units.

In terms of reviewing the inputs to the various models, I should say in self-defense that attempts have been made in the past to talk to industry.

Industry tends to say the number is $18 a ton. You say why? They say, because I said so.

MRS. HOLMES: You're talking to the wrong people.

MR. EYSTER: There is a real problem with validating anything that is said. We are in a very difficult position about simply adopting an industry number because an industry person said it's true.

The use of the various numbers in the coal supply model has been reviewed and reviewed as extensively as we can with what is in the public domain. We cannot, given the resources that we have available, come up with better numbers.

It would be nice to have cooperation from the coal industry. But, the cooperation has to be on certain well-defined terms so that whatever numbers that are generated can be verifiable and that EIA can assure itself that we're not becoming captive of the industry. That is a very real problem.

As for the demonstrated reserve base, there are problems with it, very real problems. What is most problematic is, as Dr. Gordon pointed out, basically the demonstrated reserve base is the only game in town and everybody relies on it.

However, what is critical is how one relies on it. How much are your results driven by these specific numbers? This gets us into the sensitivity area.

Sensitivity is very important and probably has not received as much attention as it should. However, it probably has received as much attention as possible given the resources we have available and could assign to it.

When we are talking about MEFS, we are talking about a very large integrated model that has demands on it for doing sensitivity analysis for everything: import prices, conservation estimates, prices in various sectors, elasticities of demand, and alternative electric utility capacity expansion plans.

There is just a tremendous demand.

True, we do make a lot of computer runs. I would be loathe to deny that. Unfortunately, for a computer run to be useful, several days of analysts' time must be spent going through it to ascertain what it really says.

It is the analyst's time that is the constraint, not the computer. If you want garbage, then we can mindlessly make runs ad infinitum. However, you won't have anything more than when you started. Identifying a good sensitivity run takes time and then interpreting takes even more time.

What you saw in the annual report is a major effort to get at sensitivity runs, perhaps not as many as you would like to have seen in different areas. The basic design of the scenarios was, in essence, a sensitivity design to bound some of the issues. Not everything was varied as much as we would like and we were not able to decompose them in the time available. But the effort was in the direction of analyzing the sensitivities.

I think that we are in agreement on the importance of sensitivity analyses. We attempted to push in that direction for the annual report. We pushed right to the bounds of our analyst time.

I'll let Charles Mylander, who is running the annual report effort this year, talk to where EIA is going because I think a lot of the questions were oriented towards, "What are we going to do in the future?" And I'm not up-to-date on that.

In terms of reviewing what model improvements are being undertaken, there are various things that I am aware of that are underway. The basic mine costing program is being revised with the focus on sensitivity and uncertainty.

It has become very apparent and we are very much aware that problems exist when you represent the world with a deterministic model. You really don't generate any type of distribution of outcomes or a level of confidence for the estimates.

The direction that EIA coal supply modeling is going is to become probabilistic. A distribution of supply curves will be generated. Thus, an analyst will be able to use the supply curve generating program to analyze some of the uncertainty issues facing coal supply. We will be able to study the impact of certain parameters in terms of changing the shape of the supply curve, shifting it around, or whatever? There will be additional work there and we can talk about that in discussion, if you'd like.

There is work being done within EIA on improving the demonstrated reserve base. There is a requirement in the PIFUA legislation for EIA to publish coal reserve estimates annually beginning in 1981. Again, there is a problem of how much money is available to treat some of these problems. EIA knows the direction that we want to go, knows where various problems lie. But we are constrained to what we can do about them in many cases.

I don't think that we have a disagreement about what we ought to be doing. We have a priority problem. There are other things that have higher priority.

Within the data validation area, we are attempting to look at the various forms that are used to collect the data that is used for the modeling efforts. We are beginning our system validation efforts to review the filling out of the forms by the companies involved, the processing of the information by EIA and how the publication of that information relates to the information that was collected.

We are looking at the integrity of those systems and trying to put some bounds on the reliability and accuracy of the information. And, that would then feed into the modeling process to give the modelers a better handle on what they are working with.

In most cases, modelers use the best that is available. We know that the demonstrated reserve base has flaws. We try to work around the flaws. We try to work within the constraints of what information is available to come up with as accurate a statement as we can about coal reserves and coal development potential.

So, I think there is very little disagreement in terms of how to do better. Our situation is similar to Ms. Holmes assessment of the synthetic fuel forecasts. We are not disagreeing with the potential of the market; just the rate of getting there. Ours is a resource constraint problem, as much as anything.

We can talk about specific areas that were brought up now and in a general open discussion. But first, Charles probably has a few things to say about where Applied Analysis is going for this current annual report cycle.

MR. MYLANDER: I'm not going to make a statement, Jerry. But, let me just pursue one thing, since it was brought up in this forum and yesterday's, regarding the need for sensitivity analysis and the need to do more in that area.

As I see it, you identified that it is not a computer problem. We can make the computer runs. I think we made more computer runs dealing with sensitivity analysis than you are able to analyze.

I think, given the page constraints that were placed upon you, you were able to analyze more than you were able to adequately write up.

So, the most serious problem, as I see it, is how should we convey the information of what we know about the sensitivity of our forecast?

One way we can do it is to do fewer base cases and more sensitivity analysis. But I have a feeling that people are not well aware of the sensitivity analyses that were done, and I'm really hoping we can explore this issue of how should we convey the information effectively?

For example, I don't know how many people realize that two interesting sensitivity analysis cases were dealt with and more fully published in the coal area than any other area of this forecasting effort.

We did a nuclear moratorium analysis and it was published. And, we reproduced computer runs and have distributed them. So, the people who wanted to analyze that issue more completely could.

We also had a sensitivity analysis run that addressed this behavior of electric utilities in switching between coal and retiring oil and gas-fired power plants. And, that was published.

But I don't think Jerry was able to make as much of that sensitivity analysis because of page constraints that were placed upon him.

Have you published or did the coal and electric power people publish any kind of complimentary report that explored these issues?

MR. EYSTER: We have a forthcoming one using the MEFS model to analyze the President's off-oil provisions for electric utilities. There is a forthcoming write-up there. But there was no publication where we analyzed the issues raised in the chapter to greater depth.

MR. MYLANDER: Essentially, you don't have analysts to write it.

MR. EYSTER: We did not have. The schedule for the coming year has built into it an analysis report covering the same material as the coal supply chapter. This report must be provided to policy as part of the Section 742 coal competition study. Thus, there will be a detailed coal forecast analysis report generated in the spring.

MR. FANARA: Yes. Dr. Gordon?

DR. GORDON: I'm going to take several minutes, if I may. About the only thing that I have ever liked about the creation of the Department of Energy was the establishment, on what I presumed would be a quasi-independent basis, of EIA.

I think Jerry has just unearthed very serious problems with this process. First, it may be that the political independence is less than it should be. More clearly, the resources being devoted to analysis are inadequate.

Unlike those of my fellow economists who would totally dismantle DOE, I would, therefore, propose that all the funds we are currently wasting on ill-advised regulatory programs such as those under PIFUA be transferred to EIA.

As far as the problems of fears of being accused of second guessing are concerned, these can easily be avoided. EIA's mandate is such that it can serve as the impartial collector of disparate industry and government views on the implication of different policies. Having indicated the range of opinions existing elsewhere, EIA can then feel free to analyze the consequences of the various extreme assumptions.

Similarly, we can resolve the problem of page limits on the reports for general circulation by arranging for supplemental reports for those of us interested enough to examine the details.

On the other side of the issue, I have been involved in various ways in the coal supply problem for five odd years. One of the things I did was sit in on an FEA-called meeting where an effort was made to assemble the troops on improving the model. Coal industry people were invited. Unfortunately, the only one present was one notorious for arguing that the problems are impossibly complex. He naturally reiterated this position and thus we made no progress.

I am pleased, therefore, that Connie indicates that there's some way to find the right people. Last time we went around--

MRS. HOLMES: It's changed in six months.

DR. GORDON: Good, because the companies were sending the wrong people, and this particular company always sends this wrong person to everything.

(Laughter.)

DR. GORDON: Two last things. I think Connie is a little unfair to the model. It does build in some of the complications. Moreover, I think Connie has overstated her points. I don't think it is true that the companies don't cost minimize, but the cost minimizing process is more complicated than the model can show. But some of this complexity is built in by constraining the system to reflect difficult-to-model considerations.

I suspect, for example, that industry is not so much inadequately cost conscious about using coal, but scared to death of EPA and Congress and what they are going to do to them.

And it doesn't help if the President tells us that the existing environmental regulations are perfect and require no alleviation.

My final point is there is very clearly one thing worse than using a model. And, that is not using one.

When you have a well-documented model where you can look at its innards and quarrel with it, you are in a considerably better position than when somebody says: My judgment is that this is going to amount to such and such.

I have just been through an exercise helping out on a review of the PIFUA rule-making procedures, where again and again we came across a situation where the model was used. ERA would not disclose how it was used--something EIA has never been guilty of. In other cases it was rather clear that, if there was any model, it was on the back of an envelope that was thrown away.

So consider the alternatives when one quarrels about modeling. Thank you.

MRS. HOLMES: I'll just say a couple of things. First of all, yes, we do agree. And, as Dr. Gordon knows, this would not always have been the case. But, the use of models certainly has enabled our analysis work to come a long way. Frankly, EIA has done a very excellent job at documenting everything that you've done along the model line and making it available to anyone who knows enough to ask for it.

There, I think you have got some problems because people do not know enough to ask for it. Charles, this may be part of the problem with the sensitivity analysis. People don't really realize that it's been done. You see a page out of a paper, as I said, or a trade journal, and you don't really realize what all has gone into this.

Even if you've got this nice book and send for it, you still don't really realize until you start going through it that you have done an awful lot of work that sometimes we, and members of mine and other industries, I'm sure, criticize you for not having done.

With respect to industry help, I really would like to reiterate, Jerry, we do have the right people to help you. Ask us again. That's all I can say. Ask us again because I think you're finding and I'm finding this only in the last year to 18 months, that our companies are hiring people who are very knowledgeable in the modeling area and who, if they weren't, are becoming more knowledgeable.

I think one indication of this, frankly, is the fact that, for the first time, the National Coal Association will use a fairly well known model which you have all used for our 1985, 1990, and 1995 projections, which we will be issuing next spring.

I think this is an indication on the part of many people in the industry that was not there three or four years ago that modeling is here to stay, and it has its very good points and it can be a lot of help.

We are fortunate in being able to work with a particular firm that allows us to use a base model and then input our own assumptions. We will be doing that and I'm sure that our results will be somewhat different than anyone else's, which is what we want.

But, it will, I hope, add a little bit, at least, to the decision-making effort.

MR. FANARA: Okay. At this point, I think we can entertain questions from the floor. If you would direct your question to a specific speaker, that would be helpful.

Yes, sir.

MR. PEARSON: I'm John Pearson from EIA. I wish to direct this to anybody but Jerry. I heard Jerry's view.

What are your views on the prospects of escalation of real coal labor rates beyond the midterm or, say, midterm plus?

MRS. HOLMES: That's a very sticky question. In fact, that's undoubtedly a good question and a very important question which you should have an answer to in order to do any type of costing work at all. That's not an answer.

The reason I cannot give you an answer is because I simply don't know. I just have no idea. It depends on a lot of different factors, most especially including the labor productivity factor. And we're just starting in some mines now to see a turn-around in labor productivity.

And I mean just starting. You know that just the most minute of turn-arounds in some of the areas would, we hope, tend to reduce our long-run real labor costs or at least offset some of the increasing costs that we might face in other areas.

But I can't answer your question because I really just do not know.

DR. GORDON: I will say that there is work going on of varying degrees of quality trying to deal with this. And I hope, all in all, you're keeping in close contact with the people working on this. The Electric Power Research Institute has a coal productivity program ongoing, done by the Conference Board.

When it's going to come out I don't know. But it has unearthed a number of things, not the least of which has provided us with some idea of a fairly substantial amount of research that is going on in various places in the government on the coal productivity problem.

Of course, the President's Coal Commission has studied that. So certainly, after the dismal forecasting experience we had in the last 10 years, nobody is going to be willing to forecast with any great deal of confidence what's going to happen in the next ten years.

But we do have a lot of people making studies. If you do take the sensitivity analysis approach, you might get some reasonable ranges to consider out of all this work.

I think that the first place to go is plugging yourself into all these efforts that are being made to deal with the question of past productivity developments and future trends.

HOLMES: A good way to plug yourself into those studies and one source for information on those studies would be to contact the Bituminous Coal Operators' Association because they've had much input into most of these.

MR. PEARSON: I'd like to ask the question a slightly different way.

How is the price of coal tied to the price of oil?

DR. GORDON: I recently wrote an essay on that.

MRS. HOLMES: Then you answer that.

DR. GORDON: Very indirectly. I have developed a simple little model which I do not have time to present adequately. Basically, the oil price sets a ceiling these days. But clearly, it's not an operative ceiling. There's a big gap between what the coal industry could get out of its present marginal customers if it priced at oil parity and what it's actually charging.

The critical considerations relate to first discontinuities in the market penetration process and then to the difference in behavior under monopoly and under competition given these discontinuities. The key discontinuities are the gross differences in the cost to different types of consumers of using coal in an environmentally acceptable manner and the differences in delivery costs of oil to any location depending on whether or not direct access by water is possible.

Oil has tended not to penetrate greatly into inland electric utility markets because the discontinuity in transportation costs resulting from the need to transport oil overland makes it prohibitively expensive to compete by shipping oil inland. Conversely, coal has been more successful retaining electric utility markets than in retaining smaller scale users because the unit costs of using coal are higher for such small scale users. It has not been profitable to sell coal at prices that undercut oil in providing energy to these smaller scale users.

In looking at why the ceiling is not operative and this is a sign of vigor of competition, we should concentrate on the transportation discontinuity. It allows the coal companies to charge a price to electric utilities no greater than the price of oil delivered to such utilities and prevent capture of the market by oil. A monopolistic coal industry would just undersell oil in such markets. Competition among coal companies, however, could force prices below the price barely low enough to keep out oil competition. Since in fact coal is actually much cheaper than necessary to keep oil out of existing coal market, we can safely presume that competition within the coal industry is indeed vigorous.

MR. FANARA: Any other questions? Yes, sir.

MR. PEARSON: What do the distinguished representatives from the industry think the future for international exports will be?

MRS. HOLMES: Very good. There are a couple of different markets. Do you want to talk about this first?

DR. GORDON: No.

MRS. HOLMES: I guess that I'm pretty enthusiastic about the long-term future for international coal movements from the United States, especially movements from the eastern part of the country to Europe.

I am not as enthusiastic, and I don't think the industry is as enthusiastic, about our export possibilities from the west coast.

For example, because we're dealing there with very long, relatively low Btu coals, if you're talking powder river basin, and no matter where you're speaking, you're talking about very long hauls, whether it be rail or whether it be slurry.

When you get into the slurry, you get into a host of political problems that sometimes seem almost unsolvable. I will tell you that there is a proposal on the table being considered by several coal companies and by the Japanese electric utility industry or the Korean electric utility, at least before Park's unfortunate demise, to build a slurry pipeline from the Emory, Utah area to Ormond Beach, California.

Cost-wise, it is like we are cost competitive. But we haven't solved the water problem by any means.

With regard to steam coal, several things have happened in the last six months to greatly improve the outlook for the European steam coal market, as far as the Appalachian coal producer is concerned and probably as far as the Illinois producer with access to river transportation is concerned.

First of all, we have a situation whereby many European countries have suddenly decided that they have to go to coal and they are all deciding this at once. They are all out scrambling for supplies, which, of course, is a very good thing for the United States because we are in a position, I believe, to expand our supply capability the fastest.

We have the most unused idle capacity laying around and it is fortunately in a fairly good spot, as far as export is concerned, because most of our unused capacity is in the Appalachian area and in Ohio, Illinois, Indiana.

Then we have the difference in shipping charges and the greatly increased charter party rates, which makes the United States coals even at, say, $35 a ton, cheaper by some $5 or $6 delivered in Europe versus the Australian steam coal, for example, or Western Canadian steam coal, which has, frankly, thrown quite a bit of spot business this year.

We are scheduled to ship out more next year and in 1981 than anybody would have forecast even 6 to 8 months ago. Long term, we're having more interest and are experiencing much more interest on the part of potential European users.

Long-term users either want partial equity, which is understandable, I suppose, or they are willing to sign anywhere from 10 to 20 to 30 year long-term contracts to ensure a supply for their power plant. And, they're willing to sign these contracts in the next year.

I think you're going to see a real sudden boom in the signing of contracts for delivery, starting in 1983, 1984 and 1985, and even as far away as 1986, within the next six months.

The third and final factor which, frankly, has pushed a great deal of interest towards the U.S. in terms of steam coal is the fact that the coal companies are not signing contracts as rapidly as they were.

In fact, they're not even honoring some of the contracts that they have. This also has been the source of a good deal of spot business for the United States.

In particular, one contract that I know did come our way for about 1.5 million, close to 2 million, tons of steam coal per year is a northern European country that was about to sign on the dotted line with a Polish company. Very frankly, they backed out and they had to come somewhere. So they're coming here.

All put together, we are pretty optimistic about the outlook for steam coal exports. But there are problems. And, one of the biggest problems, of course, is our transportation network and our port structure on the east coast. That has to be improved before the full potential that is there can be realized.

MR. FANARA: Thank you. I'm afraid our time has run out. I would like to thank our discussants, Dr. Gordon and Mrs. Holmes, and our speakers, Ms. Paull and Jerry.

We'll break for coffee now and I'm sure they will be willing to entertain any questions you might have.

(Whereupon, at 10:30 a.m., the conference ended.)

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CHAPTER 8

NUCLEAR

SPEAKERS:

1. Dr. R. Gene Clark, Energy Information Administration
2. Mr. Andrew Reynolds, Energy Information Administration
3. Mr. Clarence Larson, Private Engineering Consultant
4. Mr. Manning Muntzing, Partner in the firm of Doub and Muntzing

DR. ALT: I welcome you to the second day of the symposium to critique--or perhaps we should use the word review--the Energy Administration's 1978 Annual Report to Congress.

I also want to thank you for attending this session instead of a symposium downstairs with the more alluring title, Sex Crimes Investigations.

In this session, we address a topic that is receiving considerable attention in the news and everyday conversation: nuclear power. Currently, there is some controversy surrounding the future of nuclear power. For example, how has Three Mile Island affected the future of nuclear power? Will the Nuclear Regulatory Commission impose moratoriums on licensing nuclear power plants? What is the impact of the much heralded Kemeny report? Also, what is the overall effect on past and future EIA nuclear energy supply and demand forecasts? Now, let us review section 12 of the ARC report, which ran from pages 203 to 223.

With that, I would like to introduce our first EIA speaker, who is Dr. Gene Clark. Gene is Director of the Nuclear Energy Analysis Division of EIA.

Gene?

DR. CLARK: Well, it is a big year for nuclear, as you might guess. And, the information that was developed for the report to Congress, which hopefully many of you have copies of, was really developed before Three Mile Island. Thus, the entire set of projections is premised on the absence of this event, or at least the noncognizance of it. This fact needs to be taken into account when you are considering the results in the published volume. I would like to proceed this morning by discussing the development of the report as we see it inside the Nuclear Energy Analysis Division. Mainly, there are two aspects: nuclear power capacity availability and nuclear fuel aspects.

I think some of the interesting questions we might address have to do with the impact of Three Mile Island in light of things that are occurring today . Also, how do we see the long term? So I think those two aspects, the two ends of the transition from post-Three Mile Island to the long term, are important to consider.

With this, I would like to turn over the discussion of the nuclear power projections to Andrew Reynolds, sitting on my right. Andrew is the chief nuclear power analyst in our Division, and has been involved in these activities since 1974, I believe, or the beginning of 1975. Andy will discuss the nuclear power forecasts. I will follow up with a discussion of the nuclear fuel aspects. Then we will turn the program back to the critique.

MR. REYNOLDS: You know, if he can't remember when I came on, then I have probably been around too long. Maybe both of us have been.

We are going to use a projector here because it does assist in going through this quickly. We do have a limited amount of time, but basically I think that as a matter of explanation, our office is under the Office of Energy Source Analysis in the EIA. There are three divisions under this particular office.

We are the division of Nuclear Energy Analysis. There is also a Division of Oil and Gas Analysis, and a Divison of Coal and Electricity Analysis. So from these three structured offices, we provide the estimates of the particular resources associated with those fuels to the midrange modelers and the long-range modelers. As a matter of course, we have in our small staff, which has fortunately been together for some time, a technique of approach which we like to call the "pipeline" analysis.

It (the pipeline analysis) is unique in the sense that nuclear power, with rather long lead time for licensing and construction, is amenable to search and confirmation through the available information record. The Nuclear Regulatory Commission of course is very good in this regard. It keeps a continuing record of events for the operating plants, as well as the units that are under construction.

You may be familiar with their document system. It is called the Lord's system. The gray book is their operating record, and the yellow book represents their progress report on the construction of units. In going through this discussion, we will all understand that the Nuclear Regulatory Commission provides us with a very good resource as such, a public resource.

Our work goes into finer detail because we look at past history to attempt to determine some sort of trend in construction. We statistically analyze the track record of units that have been constructed from the time at which we first tracked the information for constructing units, which was approximately 1974, forward. And, with these statistical evaluations and the deviations about the means of these statistical evaluations, we perform a pipeline analysis on the existing units. In so doing, we provide a range of potential capacity for the future.

Naturally, this is limited as time goes on because you move out of the timeframe in which this pipeline analysis really is applicable. With that, I will turn on the slide projector and we will start with a consideration of the various assumptions that we use.

As you see here, we start of course at the very top. We have a unit-by-unit data base into which we introduce estimates of the construction lead time through the application of a commercial operation data base. Essentially, our lead time assumptions are structured into three basic categories.

One would be the licensing period. The second would be the construction period. And, the third would be the power ascension period, the time after which fuel is loaded and the unit passes through power testing and achieves commercial operation.

As I said, there is a continuing evaluation to determine how history is telling us progress is made in construction. And with these assumptions, we move forward into time with the existing pipeline of constructing units.

The construction status and duration, as it is noted there, and the licensing status and duration are all factors that go into that methodology. Once we set the entire universe of plants on this rather objective statistical analysis, we then have to consider the individual utilities constructing the units. This is important because you have possible financial constraints for certain utilities. And, naturally, demand has been probably as large a factor in the past for delaying nuclear units (as well as large coal units)--the actual deterioration of demand forecast for the future.

We have found over the years that these two factors are really on par with each other. They both have very extensive impact on the delay, or even the cancellation of major projects in the utility field. Recently, we have received a contractor's draft report through the Nuclear Power Development Office of Energy Technologies in the Department to assess the major reasons for delay or cancellation of nuclear units.

We were somewhat interested to find that their conclusions point to financial constraints and demand decline in the generating requirements as the major factors in recent years for delay and cancellation of nuclear units. We were somewhat surprised because there has been a lot of criticism directed to the undetermined position of the administration, for instance, the fuel cycle uncertainties, and intervention as other major contributing sources to delay. But, in fact, the study somewhat vindicates the notion that financial constraints and demand forecast decline have been the major contributors to delay.

Of course, cost competition with coal-fired generation is a part of the modeling structure that we introduce into the midrange model. And, basically, you have the need to consider the capacity, as you see it there, in a pipeline fashion. But, the major point is that we divide capacity in the United States over the 10 regions to which it is applicable. This, of course, affords a more careful consideration of the cost competition between generating systems.

It offers the very important notion that certain regions will just not opt for nuclear power because it doesn't really compete with indigenous resources. For instance, in region 8, the mountain states, Great Plains states, there is no nuclear capacity in the pipeline. That is a very important consideration.

As you move east from that position into region 7, Kansas, Nebraska, Arkansas, Missouri (I suppose it is), Iowa and Missouri, you have a very small pipeline of nuclear capacity. There are approximately four units there.

The Southwest is a marginal region as well. Lignite and minemouth coal plants are competitive there.

As you move toward the East, the situation changes. Region 5 is the historic bastion of nuclear generation with the Chicago-Commonwealth Edison Company.

In the North Atlantic, we have a very important position for nuclear to assist us with, and that is to remove region 1, New England, from base-load, oil-fired plants. As you all know, New England has its particular problems.

New York is a state where we have seen the nuclear program virtually cease to exist for the future due to the particular policy of the governor and his energy office there.

Region 3 is a region where coal and nuclear compete rather readily.

Region 4 has always been seemingly a pro-nuclear area and has employed a great deal of capacity. It has the largest pipeline, for instance, in the nation at the present time. The TVA is included in region 4.

Region 9 is California, and there nuclear also has its role to play. But, as we are all well aware, California seems to have eliminated itself from the mix at the present time as well.

The Northwest is dominated by the construction pipeline for the Washington Public Power supply system, a distribution utility, public utility which had no generating capacity of its own and is now in the process of building five large nuclear units, and thereby entering the world of prime movers. Thus, as hydro-capacity is exhausted, nuclear becomes the base load system of choice.

I am going to back up, because this is a graphic representation of the current pipeline, as we considered it for this year's annual report. You will see that there is a section there which we have divided between the operating reactors and those authorized for construction. This is important, because, as you look at the units with construction permits, you have several, in fact, numerous units, that have shown no progress in construction since their permit was actually awarded. We have to consider those units in a much different fashion from those units which have shown significant construction progress.

As a specific instance, in last year's forecast, or this year's forecast, I should say, the units authorized for construction, but coming above the under-construction line, are units that we would simply place in a deferrable category in our built limit structure. If the model should so opt for other capacity as economically superior, those units would be considered delayable. This is where really the flexibility in our near-term pipeline comes.

As we move out further into the future, the algorithms, the data in the licensing and construction sequence that we perform, introduces the units that are in licensing and on order. And, in sequential fashion, we introduce these units into the possible supply mix. The results for domestic nuclear power here are shown for the series C, which is called our Mid-Supply, Mid-Demand case. It is the series most specifically detailed in our chapter of the report. You see that what you are talking about, in terms of installed capacity, is the bottom row. We see a significant increase in installed capacity through 1985, over a double baseline year, 1977. This is due to the fact that a great portion of the construction pipeline is in advanced stages, and we anticipate that the range actually was 102 to 118 gigawatts for year-end 1985 commercial operation. One hundred fourteen gigawatts proved to be our best estimate of the mid-case for that year. By 1990, we saw the increase to 152 which represented essentially second or third units at multiple sites, and in some cases, first units at others. The year 1995 essentially represents an exhaustion of the current pipeline as you saw it on the last graph. In addition, approximately six new reactor orders should occur over the next four years. This came primarily as a result of looking into the model results on a regional basis and seeing that a requirement for baseload demand would so dictate the ordering of new units, or justify, let us say, the ordering of new units. So in some ways, we speculate on that particular movement. However, demand would warrant such orders and that was our particular estimate for 1995 in the annual report.

As Dr. Clark pointed out, the 1995 end point is essentially where the mid-range model stops and the long-range model takes over. We have a very significant growth occurring in fission capacity after 1995 as the long-range model begins to deploy nuclear and electricity vigorously. In the session yesterday, Dr. Pearson pointed out that it was essentially an electrified world that we were talking about, and coal and nuclear share the long-term burden.

After 1995, of course, we move out virtually unconstrained, because current problems that we cite in the near term or the midterm, as well as the pipeline analysis, are less applicable. So, essentially nuclear would be competing economically and, as it does compete very favorably economically, it deploys very quickly after 1995.

We would consider that trajectory at 2020, accordingly, as the higher bound or higher potential for nuclear capacity, because after 2000 it portends approximately a 20- to 22-gigawatt-per-year deployment rate, which is indeed vigorous. We offer some comparison to the midterm forecasts in order to give the reader some feeling about our forecasts and how they compare to last year and to the most current information coming from other noted resources. I think the most interesting numbers to compare to here would be the very bottom ones which come from the reactor manufacturers themselves. We are generally in touch with these people, and they with us. We have found that from time to time, they feel we are pessimistic, and we feel they are optimistic, and vice versa. We think that this year, at 1990, we are all coming into a range that is probably reflective of actual potential, all things considered.

But, we have to point out that since that time, events have changed since the time that the assumptions for the model were actually closed. That was the point to which Dr. Clark alluded earlier.

This is, of course, the future that we predict or estimate in the annual report graphically portrayed. By 2020, nuclear is virtually generating half of the nation's electricity. That, of course, is coming in essentially a perfect modeling world, unconstrained.

Now we would like to point out, and this also occurs or is written into the chapter, that these points are most important in our minds for a renewed rapid rate of nuclear deployment implied by the late midterm and then the long-range forecasts. The first would take back into the basic assumptions that we consider that central base-load electricity demand in the post-1990 times period is forseen to grow appreciably.

The financial concerns and constraints of the utilities are mitigated or at least somewhat alleviated. We believe that comes as a dual problem, both from the regulatory side and within the utility management itself. But, basically, we look to the rate structure, the regulatory lag, as the lead problem. I believe the consultant that just finished the aforementioned report will probably conclude that regulatory lag is the major problem for the near term. We have to go to more progressive rate structures, ones that will help relieve these cash-flow problems and get utilities starting again, namely, liquid and attractive.

The third point is clear, and that is that the problems foreseen for the future are mitigated, so that utilities see nuclear as a desirable system for future baseload service or replacement for coal systems. Fuel cycle uncertainties seem to be less a problem, because as demand decreases, and it has over the last few years, uranium availability is less of a problem. There are other problems of uranium availability that Dr. Clark will discuss.

Particularly of concern now is that the low-level waste facilities of the nation are all closed. We can't even ship low-level medical waste at the present time. We also feel that the environmental problems of burning the quantities of coal that our models would indicate are required in the long term will be compelling in the future. We would hope that, as we move through this moratorium mentality period, people keep this in mind, particularly on Capitol Hill.

We don't want to eliminate the option necessarily without some careful scrutiny of the alternatives. And, coal is certainly problematic because of its particular environmental impact and transportation problems. Of course, in a nation of our type, an open society with public debate, the complete public acceptance of nuclear power would be at the heart of a renewed deployment rate, a vigorous deployment rate in the future. As Dr. Clark pointed out, because the assumptions were closed in approximately January of 1979 and presented to the modelers for the production of the forecasts, we did not benefit from approximately nine months of information, through September, which we can offer to you now. This information from the utilities would be reflective both of construction, program slippage that was occurring continuously and, at the same time, probably is indicative of some reaction to the Three Mile Island accident.

This is really an important graphic representation again of the current pipeline. That is, the pipeline as of about September. The small beaded line is what we would now call firm capacity. This breaks into the construction permit category of reactors. It represents those units for which we believe construction is so far committed, there is no point of return. We have been somewhat shaken recently by announcements, for instance, from the VEPCO people on the North Anna site. We also believed that North Anna 3 and 4 units were somewhat soft, but we didn't anticipate that they would consider conversion to coal. I think that there might be a little more than just a technical consideration at the heart of that announcement. They probably want to shock people and motivate thought in other directions.

But we must say that when giants such as Commonwealth Edison remove 2,000 workers from a construction site where two units are about 50 percent complete, we are a little concerned, because final decisions in the state utility Commission have denied the proper, or the necessary capital to keep those projects moving for the Commonwealth system.

Similarly, the Duke Power Company, which in the South Atlantic has represented to us a utility confident of its construction plans, has similarly delayed its construction on many of its nuclear units. With that all in consideration, we have laid out for you here a comparative forecast range set for the midterm time frame. As you see in the annual report, you have a particular change at the 1990 milestone, given our current information, or our updated information since January.

By 1995 we are showing approximately a 30-gigawatt shift out of those numbers predicted in the annual report. That is unfortunate, because if all things are equal in the report, this implies that we are going to burn even more coal. At 1995 in the series C, I believe we are close to 1.4 billion tons to utility burn, 2 billion tons total production in the United States. This is something to consider. We believe that the updated nuclear numbers are rather reflective of reality at this point, although I would remind you that these new ranges have not been tested in the total demand-supply analysis model. They are probably representative of the supply potential which we will introduce into the model for next year's annual report runs.

I would just like to say one further thing, because people have talked about it. We performed in our sensitivites for nuclear power in this year's annual report a condition of moratorium which we thought was necessary, because of the climate on the Hill, even before Three Mile Island. As a matter of record, which is important, this is shown on page 220, Table 12.6. This is a rather useful table be believe, because you see the series C mid-case results for important parameters or important output, I should say, presented and compared to the various sensitivities.

The moratorium case represented a very important assumption. We said that, by January 1 of 1980, units that had not passed the milestone in construction where the reactor foundation had been poured, that is excavation had been significantly completed, didn't make it into the forecast. So we were calling that condition a construction moratorium.

As you see, we had a result that, by 1995, nuclear power was reduced to 137 firm gigawatts of capacity. It's interesting to note that the electricity generation was only slightly decreased, but coal demand increased some 120 million tons and residual oil about 50,000 barrels. Because in the midterm we have an econometric decision operating, an investment decision between the competitive capacities of electrical generation, when nuclear is constrained, coal capacity is going to take up all the slack and, rather than operate existing oil plants, the model would say it is more economic to build new coal capacity. However, the model does not necessarily consider the financial constraints of building that new coal capacity. And we introduce that caveat into the discussion. But I wanted to point out that we did already test this reduced condition to nuclear, and I think it may be as representative as anything done to date if, in fact, we see a moratorium coming down from the Udall or Hart contingencies on the Hill.

With that, I will turn over the discussion to Dr. Clark. Then we can entertain questions afterwards.

DR. CLARK: Given an assumed schedule for installing nuclear power plants, one can then go forward, compute what would be the nuclear fuel requirements to support such a program and work through to the supply side.

It turns out that the level of installed nuclear capacity is not the only parameter that needs to be considered in computing the fuel requirements. There are several other sets of assumptions that one has to consider, as shown on this slide.

The column labeled "Foreign" will not be discussed today because we are not discussing the international aspects of the forecasts in this session. If you focus your attention on the middle column, the one labeled "Domestic," you can see the types of parameters that have to be considered. The nuclear power growth is one set of assumptions. The mix of generating types is another factor to be considered. For the United States, this is a fairly easy consideration because we really only have two types. They are both light-water reactors or LWRs, as indicated on the slide. So that makes our job fairly easy for the domestic side.

A third parameter that has to be considered is what we call the power plant capacity factor, that is, what fraction of the full capacity would be realized in actual operation.

Another parameter is the efficiency of utilizing the fuel. This parameter includes such things as the thermal efficiency of the plant--the ratio of converting heat into electricity. Also incorporated is the measure of fuel performance. That is, how much energy is extracted from a given fuel element compared to its design parameters.

Another option that we don't consider for the United States is reprocessing and recycling of usable materials from the discharged fuel.

The last parameter shown is an indication of the operating mode of the enrichment plants. In other words, there is a parameter called the tails assay that essentially determines the ratio of uranium that has to be mined to the enriched uranium that goes into the power plant.

The fuel cycle cost assumptions that comprise the total fuel costs are shown in Table 12.5 of the report. I don't have a slide that shows this, but there is a breakout in that table according to the fraction of the fuel cost (as the utility burns the fuel) due to the price of uranium, the price of enrichment services, the price of fabricating fuel elements, and the price of waste disposal.

In general, we find that the most important element of this price is the price of uranium. It comprises about one-half of the cost of the nuclear fuel to the utilities.

For everything except the price of uranium as mined and milled, we generally assume some level of prices that is consistent in constant collars, that is, a price that goes up at the general rate of inflation. We did some variations for the report to Congress, though. There is a low-supply, a mid-supply, and a high-supply case. We have varied the waste disposal charges and enrichment charges on a lower or higher side, about the mid-case. The same types of variations were made for the uranium supply.

Since uranium is the most important aspect from the standpoint of its contribution to the cost and since uranium is really the major component that is in the hands of the private industry, rather than under direct government control (in contrast to enrichment and waste disposal), we concentrate a lot of attention on the uranium aspects.

Our methodology for modeling the uranium market in the United States is shown in this slide. There doesn't appear to be any input or output anywhere, but there is. The input point is shown on the left-hand side in the middle and is labeled "Demand Expectations." Essentially, it's a modeling framework that is forward-looking, in that it models the decisions people make based on expectations of future events. So the model would consider, for example, the demand for uranium based on some level of forecasts. That level of demand drives two types of activities. It drives exploration activities, shown by the box right above the demand expectations box. Further, exploration efforts are carried out on some assumed level of undiscovered resources.

If you are moving to the top right across the box, the result of the exploration activities are additions to reserves--known reserves of uranium.

This process is simulated on a year-by-year basis. The "reserves-under-evaluation" box, as you are moving over to the development phrase, implies that the development depends on the spectrum of reserves under evaluation measured against the expectation of prices, which is the box in the center.

The price expectations are initialized, using contracts that are in place today, at the beginning year of the simulation. Then some indication of what you think the price movement has been in the past for new contracts is simulated. If reserves being evaluated look favorable from the standpoint of the expected price, then development is carried out each year, and this development activity, as you see on the far right, eventually winds up as new production capability for uranium mining and milling.

At the very bottom ("uranium supply contracts"), uranium supply contracts are signed on the basis of what production capability in place is imminent and the demand expectation on the left-hand side. Price is controlled by measuring, over some time span into the future, the ratio of the demand expectation that is not under contract (who is actively out in the market looking for uranium) and is balanced against the production capability that is not committed to the contracted services. These are the actors in the market place. These supply-demand pressures cause the price to go up or down, depending on whether the supply is in excess of demand, or vice versa.

The next slide shows, as an example, the kinds of interactions you receive from this model. Prices are shown on the top scale, and quantities on the bottom scale. There are two types of prices in the model. The dots on the top are what we call the market price--the price for new contracts signed in the year indicated on the x-axis. The other price, which is the solid line, is the average price as delivered to the electric utilities. So that represents a weighting of contracts that have been signed prior to the year of delivery.

On the bottom, the open circles are the inventory levels at the end of the year in question. The solid line on the bottom is the curve of the demand for uranium as a function of time, and the solid line with the circles is the domestic production capability. Imports and exports are also shown on the bottom. Import levels are the dashed line on the bottom, and export levels are the shaded areas.

This is an interesting graph because it shows the kind of interactions that can occur in this kind of modeling framework. For example, consider the market price, as you see the dots on the top. Because of the excess of supply over demand in the bottom graph, the market price starts to decline throughout the early period. But, as the supply and demand come into balance about the mid-1980s, you see a swing upward in the price for new contracts, or the market price. Although the price is beginning to swing upward, it takes time to develop the properties (supply) to respond to that price. So the production capacity, as you see in the bottom curve, does not respond immediately. This delay maintains upward pressure on the price, although the utilities, as you see from the inventory line on the bottom, can draw down on inventories in order to match the shortfall. There is a bump on the quantities on the bottom at about 1995, which represents the response of the producers to the bump on the market price about 1990, on the upper slide.

In summary, this discussion illustrates the kinds of interactions that could occur--the dynamics of the marketplace.

What about the results? I will now show some of the slides from the report to Congress. We will focus here on the uranium requirements rather than enrichment requirements, but I will refer you to the proper figures in the text for enrichment. This slide shows, for both the domestic and foreign cases, that the series C uranium requirements, both from the historical perspective and from forecasts, continues an upward trend. The next slide shows the same kind of information, but out to a longer term, out to 2020. So it takes into account both the midterm modeling and the long-term modeling framework.

An interesting aspect of this graph is the break in the demand requirements for uranium at about the year 2000, which represents this transition from the constrained midterm to relatively unconstrained long term, although you can find in the solid area on the bottom that part of the pipeline that Mr. Reynolds referred to that is under construction and past the point of no return.

Those factors shown by Mr. Reynolds on his last slide would have to be addressed in order for anything above that line to really come about.

The enrichment aspects are addressed in Figure 12.6, page 215 of the annual report. The spent fuel, or nuclear waste component is addressed in Figure 12.7, page 216. We also carry out sensitivity analyses. In other words, how sensitive are our results to these various assumptions that were shown earlier? These sensitivities are shown in Figure 12.9.

Figure 12.9 shows sensitivities of the uranium, enrichment, and one component of the waste storage problem (the requirement for away-from-reactor spent fuel storage). It depends on which particular parameter you are looking at as to what the most sensitive input is.

Now again, for discussion on the uranium aspects (Series C), this curve shows prices and quantities for the particular condition, both its new contract base price or market price at the top, and the average delivered price as new contracts are signed, weighted by the prices shown in the new contract price. You see the average delivered price to the utilities increases as more contracts are signed in the future.

The bottom curve shows how we translate the basic uranium requirements into uranium demands on the marketplace. What starts off as the bottom line would be the requirements for uranium in order to meet the needs of the power program. The line that starts as the upper line shows how the uranium contracts are constrained by enrichment services contracts.

The government has enrichment services contracts that lock in utilities to certain schedules for uranium delivery. Therefore, if a utility delays its plant at the last minute, it's still locked into taking enrichment services, and therefore delivering uranium to the enrichment plants to be enriched on the old schedule. For series C, we have assumed that, in the near term, people are locked into their enrichment services contract schedules, but there is an adjustment that is carried out so that by the end of the period, the two lines more or less merge.

The lines shown on the price schedules represent uncertainties due to what we call behavioral parameters in the uranium market model. These parameters include such things as how far into the future do you want to sign uranium contracts, what is the investment risk criterion for uranium--the kinds of parameters you can't go out and measure from the data in the real world. So we handle their sensitivities by varying them all, and seeing how sensitive the results are to them.

This is my last slide. It shows how sensitive this uranium market price is to the various input assumptions, from 1985 to 1995. You can see from this graph that the solid yellow bars show that the 1985 price is most sensitive to variations in these market psychology or behavioral parameters and to the assumed level of installed nuclear power capacity, or what is called demand. But, as you move out towards the end of the period, other parameters become just as important, such as the mine and mill construction cost and the drilling discovery rate. However, uncertainties in the size of the resource base become overriding, as you get towards the end of the period and begin to see resource depletion effects.

That concludes my part of the discussion.

DR. ALT: We thank you, Dr. Clark.

Before we address any questions, we would like to move to our other speakers, first. We were very fortunate in obtaining the two speakers that we did from the non-EIA sector.

Our first speaker is Mr. Clarence Larson, who was a former Commissioner with the Atomic Energy Commission, and who is now a private engineering consultant.

Mr. Larson.

MR. LARSON: Thank you. I might begin by complimenting the Department of Energy on this sort of approach of getting out a report and getting feedback. I think it's a very enlightened approach to getting some feedback from the public and from other parts of the industry.

However, after saying that, I should like to make a few general remarks about some of the general principles involved in the cost of nuclear power. I'd like to particularly focus on what effects some components of these costs make because I think by a quick reading of the report, there could be some misunderstanding. Admittedly, I may not have read it carefully enough. But, I think I will give you some examples.

Let's take the principle that the cost of uranium or the cost of fuel is an important part of the cost of the electricity generated. Now, that is true up to a certain point. But, consider that at one time we thought that uranium would never rise to $40 a pound. As a matter of fact, in past histories of a country, uranium has sold for below $1 a pound. But, up until at least 10 or 15 years ago, it was $5, $6, and $7 a pound. And now, $40 a pound is commonly thought of as an appropriate amount.

So this seems like a horrendous increase. But let's examine what effect that has. At $40 a pound, the cost of the fuel cost of the electricity is only about 3 mils, or perhaps at the most 4 mils, depending on whether you reprocess or did not reprocess.

So I think when we are talking about the future in which we are going to be paying 75 mils per kilowatt hour for electricity, we shouldn't cloud the issue by focusing on something like the difference between 3 and 4 mils per kilowatt hour so far as the fuel is concerned.

I think that the other point is that there are other factors that will influence the demand of nuclear power in the future. This has been dramatically exhibited in the last year. That is, what is the effect of the interest rate on the cost of nuclear power. Of course, all of you are familiar with the fact that the interest rates have almost doubled during the past two years. And the financing, therefore, of any power plant, nuclear or otherwise, will be profoundly affected by the capital costs of the installations.

Since nuclear is very capital intensive, the effect of rising interest costs will dwarf anything like the cost of the rise of, for instance, uranium. As an example, I think the capital cost now for a nuclear power plant is probably between 25 and 30 mils per kilowatt hour. That has increased over the last year, until now we are looking at some capital costs that are pretty close to 40 mils per kilowatt hour for nuclear power plants. So there is a peculiarity about nuclear as contrasted with coal and gas.

On the other hand, a gas-fired plant costs very little, but of course the fuel cost is tremendous. During part of my long and checkered career, I had the responsibility for generating some of the power at the Oak Ridge diffusion plants, and we thought that power at less than 4 mils per kilowatt hour was what we would more or less always have. Now, of course, that has gone.

You can see we are a factor of 10 or more over that in some areas of the country at the present time. So I think in order to look at all of these costs, we have to look at various segments and find out which part of these segments are the important costs of nuclear power.

I might mention, for example, the separative work expense. At one time I think we charged something like $25 per separative work unit. I think we are now charging something like $90 per separative work unit. But again, that is only perhaps someplace between 2 and maybe 3 mils per kilowatt hour.

In spite of these very large increases, it is a very small amount. However, this particular thing has come up with regard to new capacity. How fast we should actually build new capacity. And I have always unsuccessfully been an exponent of building enrichment capacity only when we have firm orders in hand.

The logic of this, of course, is apparent to anyone in business: you don't buy and tie up your money too early, even at lower interest rates. In this particular point in time, it is vitally important. In fact, the interest during construction now at these very high interest rates of 12, 13, and 14 percent, will give rise to sometimes an almost doubling of the cost of some of these capital projects as they go along.

So I would like to throw open the matter that we must look at all of the costs of nuclear generating, and focus on their particular important relationships to each other, rather than worrying perhaps a little bit about whether or not if it goes from $40 to $50 a pound. This you won't even know on your light bill at the end of the month.

However, there are some very important things that you all know, and that is interest rates, capital costs, how much we have to apply for transmission costs, environmental costs, and so forth, can easily double the cost of your electric bill.

So I would just like to throw open some of these other economic considerations for consideration as to how they would affect some of the forecasts as you go along in the choice between nuclear, gas, coal, and hydropower, and so forth.

Thank you.

DR. ALT: Thank you, Mr. Larson.

Our next speaker from the non-EIA sector is Mr. Manning Muntzing. First, I would like to offer my sincerest apology to him because in the initial flier for this symposium, we misspelled his name. I hope he doesn't hold that against us.

Mr. Muntzing was a former Commissioner with the Atomic Energy Commission. Now, he is a partner in the local law firm of Doub and Muntzing.

MR. MUNTZING: Thank you, Mr. Chairman. You corrected the spelling of my name, but unfortunately, you missed my position. I was not a former Commissioner. I was a former Director of Regulation for the Atomic Energy Commission.

I would like to divide my comments this morning into three parts. First, I want to comment about the DOE study itself, in particular, Chapter 12. Secondly, I want to talk about studies such as this and what is their rationale and purpose. Finally, I want to talk about Three Mile Island.

Let me just dwell very quickly on Chapter 12. As a lawyer, I just can't resist reading the language and thinking whether it's correct or not, or whether I agree with it or not. So I will give you a few nits and gnats.

On page 203, you say in the second paragraph that the lead time for nuclear power is 10 to 12 years. Then on page 222, and I didn't see anything in the middle to justify a change, it's 11 to 13. I don't know what it is, but it ought to be the same. It's either 10 or 12 or it's 11 to 13. I am not sure about those figures in any event.

On page 208, I see in talking about Three Mile Island that you say that "no fuel melting appears to have occurred." I think that is an assumption that probably will not stand the test of time.

In addition, in that same paragraph, you talk about the release of radioactivity, but I think that is quite misleading. In fact, the releases were very small. If there is anything that the Kemeny report came out firmly on was that the releases did not have any impact on the health and safety of the public.

Finally, on page 212, you indicate that the cost impacts, this is in the second column, with construction of nuclear power are due to the design changes for safety and environmental controls. I think that the studies that I have seen put the principal cost increases on inflation and escalation, and not on safety and environmental controls.

In fact, if you look at the history in the last five years, I think you would have to be very cautious about what are the safety and environmental design changes in the reactor that have changed and contributed additional cost.

Finally, you indicate that the impetus for these design changes is the ACRS. That was 10 years ago. ACRS influence is not that strong, and it is the staff of the Commission that is the impetus, and it is really the people who require the changes that are made. The ACRS is more of an oversight body and has been for some time.

Well, those are sort of nits and gnats, and I don't want to dwell on those at any great length.

Secondly, let me talk about studies such as this. One of the real questions is what is its purpose, and who uses it. I am not sure just where we come out on that here. I have been involved in these studies in the past. At one time, they were used for decision-making purposes. That, of course, I think was quite good. Sometimes they tend to be used to justify programs, or to convince OMB to add more dollars and more people to the program, or to fulfill some Congressional mandate just because it has to be done.

If that is the case, I think it's sort of a useless exercise. In fact, I wonder why we need to do it. What I am really saying is this: if the people who prepare this report are interested in it, they ought to make sure that its real use is effective.

What I mean by that is that if Secretary Duncan does not read it, use it, rely on it, and base his policy on it, I would abandon it. There is no point in going through the exercise. I don't know whether he does or he doesn't. Secretary Schlesinger was always a rather strong individual for planning analyses such as this. In fact, some of his ideas, sensitivity parameters and other items, are being followed that he instituted years ago, because he was quite interested and did use it for decisions.

But if the new secretary and the new leaders of DOE do not use it, it is probably not worth keeping on the shelf. What I am really recommending is that the authors ought to make sure that it is more than just an interesting historical record and see that it is in the center of decision-making programs, or else it really has little value.

Finally, let me talk about Three Mile Island. It's sort of like World War II. If you can get through it, it will be terrific.

Back 50 years ago, we had the great economic crash, and the nation economically was in difficulty for many years. With World War II, we finally came out of it. In fact, American technology and American influence throughout the world was certainly enhanced by World War II. I guess after it was all over, if there was any good part about it, it was that the United States had recovered economically and had established its position worldwide; and for all the costs that were involved, in the long run, maybe it had an advantage for the United States.

Three Mile Island is just like that in my mind. If we can live through it and pay the cost, it will be good for nuclear power. One of the great difficulties prior to Three Mile Island was a general complacency within all sectors of nuclear power with regard to safety. And, this started at the very highest echelons of government, such as the President and the Congress as typified by the fact that they constrained budget and resources many times. And they appointed people to the Commission who knew, and know currently, nothing about safety of nuclear, or very little about safety of nuclear power plants. And that permeated the regulatory program.

There was a great divergence of resources and interest on nonsafety questions. And, of course, it affected the industry. People began to believe the basic positions that had been taken, and not eough attention was paid to the safety problem. So, I think that there was a general complacency, and Three Mile Island has at least turned that around.

Now, the question is, can we get through the problem, through the aftermath of Three Mile Island? We have the Kemeny report. I think it's a rather good document. It's critical, it's tough, it's done by people who have no particular vested interest in the nuclear option one way or the other. It has some good points in it. The problem is whether, in fact, the 12 good and learned people who did that will be supported in their opinions, or whether people will use it as a base, and insist upon going further.

I am told that today in the White House, there is a meeting of the President's Committee to evaluate the Kemeny Commission report and to make a recommendation to the President. While they are dealing with what you would expect them to deal with, in addition, they are dealing with questions as to whether there should be a moratorium on future licensing.

The Kemeny Commission did not, as a majority, come out in favor of that, although some of the things they recommended would tend to have that impact for some limited time. But, in fact, they chose to take it on a case-by-case approach. I think that is probably not a bad way to do it.

You know, we ought to keep in mind that the five operating reactors that are going to be affected by the Kemeny Commission recommendations (they are near operating status, but will not be authorized to go forward immediately until operator training is improved, evacuation plans are developed, and some safety issues are reviewed) are equivalent to the supply of oil we get from Iran. In all of this, I think that people tend to forget that there are trade-offs in energy. We would all like to have natural gas. It seems to be relatively safe and sometimes inexpensive, but one of these days we are going to run out of it. That is the problem with natural gas.

So there are risks and trade-offs, and certainly nuclear has risks. But it does, I think, have a place to play. Now, with regard to the Kemeny report, I was a little struck by the fact that previous speakers kept referring to what Congress may do concerning a moratorium based on the Kemeny report.

I think the major question is: what is this administration going to do? What is Secretary Duncan's position? And what is President Carter's position? I think that is awfully important, and we yet have not heard from them. I know that it takes time, but I do hope that they approach this in a manner that looks at the broad picture for the nation and not just small particular problems.

There are several basic problems--principles that strike me as important for the nuclear option. In fact, there are eight that I would mention just briefly. I think it's important to keep them in mind as people think about the nuclear option. The first one is that the responsibility and authority for the safe operation of a nuclear power plant belongs with the licensee, the entity that is the owner and the operator. They are there 24 hours a day, 7 days a week. They know the plant well, and the responsibility must be placed upon their backs. Those people who talk about nationalizing the industry, I think, are not thinking clearly as to what is in the best interest of nuclear safety.

I think that in cases of emergency, or of some accident, the people who must be held accountable, again, are the licensees, the owners and operators. And people who advocate that, in an emergency, the Nuclear Regulatory Commission or some administrator take it over and run it, again, I think miss the point. The people who must be held accountable are those who know it and who are there, and to indicate that if you get in trouble we will take over and solve the problem for you, I think is not conducive to good safety.

Thirdly, I think that one of the basic principles is federal regulatory programs. It isn't so important whether it's a five-man commission, which I prefer, or an administrator. It is that there is a viable organization at the federal level that brings together the needed resources to regulate an industry in a tough but fair manner.

Fourthly, that regulatory oversight by the Federal Government should concentrate on public health and safety. In other words, protecting the public from radiation. In the past several years, the Commission has been diverted by looking at international problems, export licenses, antitrust considerations involving competitive issues, and water, sea, air, in a non-radiological manner. I think that these things have diverted their attention from their primary responsibility, public health and safety, as far as radiation is concerned; and, it would be well to get back to the principal purpose of the regulation, and if necessary, send the international affairs off to the Department of State, and the antitrust affairs off to the Department of Justice, where they probably really belong.

Fifthly, I think that the regulations should not be diluted by giving individual states a veto power. The public policy here, I think, is well stated from the very beginning. That is, the government oversight cannot really expect to be effective on a 50-state basis. You can bring together at the federal level sufficient resources to regulate the industry effectively. And to think that you can do it on a state-by-state basis, I think, misleads the public and is not realistic in the final analysis.

Sixth, there is something that has not occurred, a basic principle which has been essentially ignored. And it is time that we add it, I think, to the nuclear option. And that is the private sector itself must have a regulatory oversight role.

Now, we hear of the establishment of INPO, Institute of Nuclear Power Operations, and various safety groups under the auspices of EPRI, but it's long overdue.

Where has the industry been? Well, the answer is that they have relied on the Nuclear Regulatory organization, and they have done what that organization said was needed instead of what they thought was needed. The private sector has great resources. Three Mile Island showed that they did, because of the response to it.

I think the industry itself must move to regulate itself to a greater degree than it has before. In fact, it really has not in the past, and it's about time that it does.

Seventh, in this system which I am describing, you do have divided responsibilities between the licensee, the industry as an entity, and the federal regulator. The interfaces are quite important, but problems of overlapping regulatory programs are usually ignored.

Realistic concepts are not used, ultraconservatisms are used without rationale, the approach to regulation is often such that there are more disincentives to effective safety than there are incentives to it. And that, I think, needs to be straightened out.

And finally, it seems to me that there is a political matter here in which the Congress and the President of the United States must decide whether we will have nuclear power in this country. For some reason, various Commissioners of the NRC think that this is their responsibility. It is not. It never has been, never should be. Their job is to regulate, and not reach that social decision. The President and the Congress should face up to it and make a judgment.

What does Three Mile Island mean to a report such as this? Well, it's a little early to tell. But I think it will become clear within the next six months. I suppose at this point, all we can do is guess.

I think it is safe to say that the 72 plants that are operating will continue to operate. The 90-some plants that are under construction or authorized for construction probably will be completed. And the principal question is, will there be an expansion of nuclear power beyond these 150, 160 facilities? Congressman Udall, who has a very important role in all of this, I think would answer the question in the negative. Although, as I read the Congress on this question, I think Congressman Udall is not in the majority of the Congress as it exists today.

The coming election will obviously focus on this. And the new president will have strong impact on the question as to whether nuclear power expands from 150, 160, 170 facilities. So we cannot know the answer at this time. It is my basic feeling, however, that there are many nations in the world who have no option, as maybe the United States has. I include in that such countries as Japan and many of the industrialized nations in Europe.

In light of the fact that we have the INFCE review in February, I think we will see at that point reaffirmation by most of the nations of the world of the need for nuclear power. This must have its influence in the United States. As we continue to have problems with the supply of oil, as we continue to have problems with the rising cost of fuel generally, nuclear power will play an important role. The extent is, in my judgment, unknown at this point. But I think that by the time a report such as this is prepared about a year from now, a number of the uncertainties will have disappeared and we will have a clearer projection.

If I were looking into a crystal ball, it would be my basic feeling that the changes recommended by the Kemeny report and by other studies will be made, the soundness of nuclear power and its benefits and its risk for the public will be appreciated and accepted, and that we will see an increasing use of nuclear power through the early years of the next century.

And I would expect that the orders will come back in about 1985 to the late '90s, and we will see a trend that is not dramatic but is a trend toward increased use of nuclear power. Those who advocate its elimination as an option, I think, will not prevail, and should not. But while we will not see the great growth that had been anticipated at one time, there will be increased usage through the years.

DR. ALT: Thank you, Mr. Muntzing.

Would either Gene or Andy like to take a brief time to reply? Then I would like to open the meeting for questions.

DR. CLARK: There are two points I would like to cover--the two most important ones, I think, that came out.

The first is that, in the area of costs, there seems to be some confusion on the question of the role of inflation and how we treat inflation in computing the costs. We tend to look at things in constant dollar terms, that is, on the basis of a constant purchasing value of the dollar.

If you took any of these price streams, and you had your own rules for what you thought inflation is going to be, you would increase what had been a level price stream in the report at the rate of inflation. Inflation makes the treatment of things fairly complex. That is why we like to try to take out the inflation impacts.

If you take out the effect of inflation, I think the 75 mils-per-kilowatt-hour number is deceiving for the construction costs of nuclear power, because of the way the plants are financed once that construction cost is established.

Then as you move out through time with inflation, the amount of the generating cost that is due to that component actually declines. So the numbers that we put forth in the report represent some average over the life of the plant. When you consider it in those terms, the total nuclear fuel cost is about 6 mils-per-kilowatt-hour, the uranium component of which is about 3, and the remainder is somewhere around 25 to 30 mils-per-kilowatt-hour. So the net effect is that the uranium component of the generating cost is about 10 percent. If you look in the report, you see the uranium prices going up almost a factor of two over the time frame we are looking at. So this component would actually be going up to about 6 mils-per-kilowatt-hour by the end of the period. I think it is important to keep that consideration in mind.

MR. LARSON: See, that would be something like 80 percent, you are think of $80 per pound for uranium?

DR. CLARK: Right, at the end of the time period. That is in today's dollars. So if you felt the rate of inflation were going to be 10 percent a year, it would be much past 80.

PARTICIPANT: You said 10 percent?

DR. CLARK: If one would assume that the rate of inflation were going to be 10 percent over that period of time, then even $80 would not be right. You would have to take 1.1 times however many years it is.

PARTICIPANT: Did you put in any kind of escalator in your capital costs?

DR. CLARK: Yes. As a matter of fact, the construction costs for the long-term period include not only a design basis that would apply if the plant were built today, but also some resolution of safety issues that would add some construction costs to the plant and the trend over the period for some escalation (above the rate of inflation) of the components, like the labor costs, material costs. But typically, this component would start off at maybe 4 percent above the rate of inflation, would decline to zero so that those rates would go up at the rate of inflation after either 1985 or 1990, depending on the service. But that is an area of uncertainty that was addressed yesterday. We don't know what these differential rates will turn out to be.

PARTICIPANT: What is the lead time for a nuclear power plant right now?

DR. CLARK: Since nobody's ordering any, we are not sure what the lead time is between ordering and coming on line.

PARTICIPANT: For your projection.

DR. CLARK: Okay. We look at a range of construction times around 82 months. Ninety-six months would be an average long time and 74, I believe, for the short time. This we obtain from a statistical analysis. This is from the time you start pouring concrete at the site to the time you are ready to load fuel for the plant. This is what we call the construction period.

MR. REYNOLDS: Those are detailed a bit on page 212, under uncertainties.

DR. CLARK: The second point I think that needs to be addressed is the purpose of the study. This was covered somewhat yesterday. But we, the Energy Information Administration, are a semiautonomous group, forbidden to engage in policy advocacy or design studies, except through analysis support to other groups, at their request.

This report is required by Congress. We are required to be policy neutral. So the way we handle the policy dilemma is to assume that today's laws and regulations continue into the future. Thus, we have uncertainties in the report, but they are not uncertainties on the policy side.

The usefulness of the report then is that this kind of information can be, and is used as the base case for other policy studies done at the department. So there is a baseline from which you can measure the impact of a policy change. That has been the usefulness of this report to people. I don't know if the Secretary reads it or not. Maybe not.

DR. ALT: Mr. Muntzing, Mr. Larson, would you care to say anything?

MR. LARSON: No, I don't have anything more.

DR. ALT: Are there any questions from the floor?

If you would, please tell us your name.

MR. LEON GREENE: I am a consultant in Washington. I forget whether it was Mr. Reynolds or Mr. Clark who made the remark earlier in his comments that the factors which were discouraging utility investments in nuclear plants were financial difficulties more than regulatory delay and intervention.

Well, my question is: aren't those two sides of the same coin? As Dr. Larson pointed out, the more you stretch out the thing, the worse your financial bind gets. I don't see how you can distinguish between the two.

MR. REYNOLDS: You can because there is a difference between regulatory questions, which indeed do occur. As the staff comes up with a recommendation for a design retrofit, naturally you have to implement it during construction.

The basic problem is that nuclear power has gone through a tremendous learning period. We have a succession of three vintages of plants, for all practical purposes. As you moved into progressively larger units, the scope, the design, the actual equipment and cement going into the plants have been so drastically different that you find a problem in construction--that the lead time is associated with essentially the size of the unit.

The Japanese have claimed that they can build a plant in 48 months and, in fact, they built the 500 megawatt Shimane reactor in that time. Every plant since that particular project has been constructed in far greater time, however. The two recent plants of Westinghouse designs have been built in approximately 72 to 80 months. This follows the history all around the world. The French, the Germans, the U.S., and now the Japanese have all experienced this construction lead-time escalation.

So the regulatory does have an impact. But, by the same token, it's a design change that is assumed in the normal scope of plans as you are going to larger and larger units.

I wanted to say one other thing to this gentleman. In our capital cost assumptions, you naturally have an increase in interest during the construction cost fraction, as you have a larger lead time.

So as we move to larger statistical differential between mean construction time, naturally the associated cost increases.

MR. DAVID BOONIN: I am from the Pennsylvania Public Utility Commission, and we don't know anything about TMI, or anything up there.

MR. MUNTZING: That's one of the problems!

PARTICIPANT: When you use interest-during-construction-type of input, are you using some sort of real rate since you are netting out inflation?

DR. CLARK: Yes.

PARTICIPANT: What real rate are you using, 4 percent?

DR. CLARK: The cost of capital to the utility, I believe, is something like 4 percent above the rate of inflation.

MR. REYNOLDS: 4 percent real.

DR. ALT: I believe there was one more question

MR. ERNIE SCHOEN: For the lead time you project, does this include design, the safety analysis, and all of the factors that come before pouring concrete?

DR. CLARK: No, it only includes the time of actually constructing the plant.

PARTICIPANT: If you started from scratch today to build one, how long would it take you?

MR. REYNOLDS: The construction?

PARTICIPANT: No, from start.

MR. REYNOLDS: Order the unit and docket the CP?

PARTICIPANT: Suppose I want to get started today?

DR. CLARK: It depends on who you are, what utility you are and how carefully you want to build a plant, you will have to scope out your needs. Essentially, design a request for bids, design your plant somewhat. That may take you a year, say. Then you announce to the world that you want a bid for contract for somebody to build the plant.

It might take another six months or year for you to get back your bid, in other words, to choose who is going to build the plant. Once that criterion is set, you need to decide to go to the Nuclear Regulatory Commission and get a license, right? So maybe that is another six months to two years, filling out all the paper work that has to be done to submit to the Nuclear Regulatory Commission.

Then the NRC has to license the plant for construction. That can take anywhere from 20 months on. Some plants are still bouncing around in the system that have been there for 50 months. So it all depends on, first of all, how serious you are about building the plant, how well you do your homework, and how lucky you are.

If you submit a lousy application and there are a lot of questions going back and forth, or there is a lot of intervention in hearings, then that will stretch that time out. So there is a lot of uncertainty in this.

Once you have your authorization to begin construction, then you move into this (construction) period of time. So you can see about the relative importance. One year. One to two years. Call this two to four years. And this is six to eight. That will give you some idea of the time it takes. Maybe this will answer your question of 10 to 12 or 11 to 13.

PARTICIPANT: Maybe 15. Could be as much as 20.

DR. ALT: I would like to ask one brief question. Apparently, the worst-case analysis presently is for the situation of a moratorium. However, in testimony given by NRC Chairman Hendrie and in questioning by Representative Moffett of Connecticut, he is quoted as saying that some existing plants may be forced to close down due to "a very, very serious lack of planning." Will this be the new worst-case analysis.

MR. REYNOLDS: This would probably refer to the notion that units operating without state evacuation plans, or local evacuation plans must be closed.

DR. ALT: Right.

MR. REYNOLDS: That would certainly be considered. We have actually done a short-term analysis for 1980 based on a series of cases which consider these graduated problems. One of the cases is a situation where units that have no state evacuation plan or local evacuation plan are removed from service. Or units that would be projected to receive an operating license, that is, to load fuel, would be denied that license.

That is a report that was just published, which is available. We could make the title available to people.

DR. ALT: Thank you. It is now 10:37, so we have run over slightly.

PARTICIPANT: Will this reconvene after a coffee break, or is this the end of the session?

DR. ALT: This is all the time we had allocated to the nuclear session. After the coffee break, the agenda calls for a continuation of the oil and natural gas session. This is followed by a session on electricity.

Right now, there are two coffee breaks. One is in room 1123 and the other is in room 0123. I think the closest one to us is room 1123.

I thank you for attending the session and hope you enjoy the symposium.

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CHAPTER 9

ELECTRICITY

SPEAKERS:

Ms. Betsy O'Brien, Energy Information Administration
Mr. Jerry Eyster, Energy Information Administration
Dr. R. Gene Clark, Energy Information Administration
Dr. Martin Baughman, University of Texas at Austin
Mr. Jerry Karaganis, Edison Electric Institute

MR. FANARA: I would like to welcome you on behalf of the College of Business and Management of the University of Maryland and the Department of Energy to this session on electricity.

Our speakers on this panel will be, on my left, Ms. Betsy O'Brien, who is Operations Research analyst in the Coal and Electric Power Division of the Department of Energy. On my near left is Professor Martin Baughman of the University of Texas at Austin, Professor of Electrical Engineering. And, on my far left, is Dr. Gene Clark, who is the Director of the Nuclear Analysis Division at the Department of Energy.

On my near right is Mr. Jerry Karaganis of the Edison Electric Institute. And, on my far right, is Mr. Jerry Eyster of the Department of Energy.

We will stick to as stringent a format as possible, by having each speaker speak for 15 to 20 minutes. Then, we will give each speaker 5 minutes for rebuttals or points of correction. At that point, we will open up the discussion to the floor.

Our first speaker with prepared remarks today from the Department of Energy will be Ms. Betsy O'Brien.

MS. O'BRIEN: Thank you.

I'd like to give a brief description of the model that was used in making our projections, identify some of the key variables, and then compare the results from two of the scenarios.

Can I have the first slide, please?

(Refer to Figure 9.1)

The electric utility projections were made using the electric utility dispatch module, which is a submodule of the MEFS model. The projections represent optimal decisions on power plant construction and operations that minimize marginal cost of producing electricity.

ELECTRIC UTILITY DISPATCH MODULE

- MINIMIZE MARGINAL COST OF PRODUCING ELECTRICITY
- 10 DOE REGIONS
- ANNUAL LOAD DURATION CURVE
- MINIMUM REGIONAL RESERVE MARGIN
- 23 CONVENTIONAL PLANTS
  8 NEW TECHNOLOGIES

Figure 9.1

The capital cost component in this marginal cost is a levelized cost over the life of the plant. The model operates at the DOE regional level, and there are no regional transfers of power assumed in this model currently.

The demand is represented as an annual load duration curve, and this curve is subdivided into four categories: base, intermediate, daily peak, and seasonal peak demand. Plants are dispatched to meet demand in a particular mode of operation.

Regional reserve margins are specified as a minimum requirement. Therefore, results from some scenarios project reserve margins that exceed the minimum requirement.

Twenty-three conventional plant types are modeled and eight new technologies. The plant types are subdivided by the generating technology, i.e., steam, turbine, or combined cycle, and also by the fuel consumed.

The next slide, shown as Figure 9.2, will show the 23 conventional plants. The coal-fired powerplants are further subdivided by heat content of fuel, sulfur content, and whether or not the plant has a scrubber.

The next slide, please.

(Refer to Figure 9.3)

This slide shows a list of the new technologies that were considered. Next slide.

(Refer to Figure 9.4)

Assumptions were made about the implementation of federal and state regulations. For the Powerplant and Industrial Fuel Use Act (PIFUA), no new oil plants were allowed to be built except for those under construction.

Gas use was limited in 1990 to 20 percent of the current consumption.

Conventional Plant Types

Oil Fired Steam

Natural Gas Fired Steam

Nuclear

Coal Fired Steam
- Bituminous/High Sulfur/with Scrubber
- Bituminous/Med Sulfur/with Scrubber
- Bituminous/Low Sulfur/with Scrubber
- Subbituminous/Med Sulfur/with Scrubber
- Subbituminous/Low Sulfur/with Scrubber
- Lignite/Med Sulfur/with Scrubber
- Lignite/Low Sulfur/with Scrubber
- Bituminous/High Sulfur/no Scrubber
- Bituminous/Med Sulfur/no Scrubber
- Bituminous/Low Sulfur/no Scrubber
- Subbituminous/Med Sulfur/no Scrubber
- Subbituminous/Low Sulfur/no Scrubber
- Lignite/Med Sulfur/no Scrubber
- Lignite/Low Sulfur/no Scrubber

Distillate Fired Combined Cycle

Gas Fired Combined Cycle

Hydro Pondage

Hydro Pump Storage

Distillate Turbine

Gas Turbine

Figure 9.2

NEW TECHNOLOGIES

- GEOTHERMAL
- SOLAR THERMAL
- PHOTOVOLTAICS
- WIND SYSTEMS
- BIOMASS ELECTRIC
- OCEAN THERMAL
- LOW/MED BTU GAS-COMBINED CYCLE
- CENTRAL ELECTRIC AFB

Figure 9.3

Key Variables and Assumptions

- Federal and State Regulations
  - PIFUA
  - Clean Air Acts Amendment 1977
  - PURPA
- Generating Capacities
  - Existing and Planned Additions
  - Mandated Conversions
  - Model Decisions
- Capital Costs
- Fixed Charge Factors

Figure 9.4

For the Clean Air Act, existing plants were required to meet state sulfur emission standards required by the State Implementation Plans. New plants under construction were required to meet a New Source Performance Standard of 1.2 pounds of sulfur dioxide per million Btu.

Other new plants had to meet the Revised New Source Performance Standard of .67 pounds. The Public Utilities Regulatory Policies Act (PURPA) required that rate commissions review pricing policies to reflect the cost of producing electricity at specified times of the day.

This was modeled by assuming that peak demand would be reduced in response to higher prices, but there would be no reduction in total demand.

This would result in an improvement of the load factor of 1 percent, 3 percent, and 5 percent over the years 1985, 1990, and 1995, respectively.

The capacity represented in the model is divided into existing capacity and new capacity. Information reported by the utilities to the Department of Energy is used to obtain existing plant capacity and also capacity under construction.

These plans for capacity expansion are reported through 1985. Conversions ordered under the Energy Supply and Environmental Coordination Act were modeled requiring plants to change the fuel used from oil and gas to coal.

We assume that 12.6 gigawatts of oil-fired powerplants and 3.8 gigawatts of gas-fired powerplants would be required to convert to coal.

Any additional capacity required to meet demand is a model decision based on minimizing the marginal cost.

For the capital costs, we assume no real cost escalation over the years. The capital costs for new coal plants with scrubbers range from around $500 to $600 per kilowatt in 1975 dollars.

The fixed charge factor is used to convert the new plant's capital investment cost into an annuity extending over the economic life of the plant, which we assume to be 30 years.

This factor is approximately 9.4 percent for coal plants.

May I have the next slide, please.

(Refer to Figure 9.5)

Now I'd like to present some results that compare the series C scenario, our mid-range estimate, with a sensitivity run, no early oil plant requirements. Coal consumption projections are high due to assumptions about the implementation of the Power Plant and Indusdrial Fuel Use Act, the high world oil price, which causes conversions from oil plants to coal; and also the shift in consumption to off-peak hours due to time of day pricing.

The nuclear projections were made before we included any effect from the Three Mile Island accident. The demand growth, that was assumed in these projections, was approximately 4.3 percent per year average annual growth rate.

Can I have the next slide, please?

(Refer to Figure 9.6)

This slide shows the capacity projected to exist in 1990. As you can see from the two cases, we show 70 additional gigawatts of coal capacity in series C. Also, the reserve margin in Series C is projected to be 36 percent versus 28 percent when we limit the early retirement of oil plants.

The utility capacity expansion plans reported to the Department of Energy project 300 gigawatts of coal capacity by 1985.

ELECTRICITY FUEL USAGE AND GENERATION
PROJECTIONS FOR 1990
(QUADRILLION BTUS)

	SERIES C	NO EARLY OIL PLANT RETIREMENT
FUEL USAGE		
FOSSIL FUELS		
COAL	22.05	18.55
OIL	3.17	6.67
NATURAL GAS	.51	.61
SUBTOTAL	25.73	25.83
NUCLEAR	9.43	9.44
HYDRO	3.15	3.18
NEW TECHNOLOGIES	.34	.38
TOTAL INPUT	38.65	38.81
EFFICIENCY LOSS	25.98	26.12
TOTAL GENERATION	12.67	12.69

Figure 9.5

Electric Utility Generation Capacity and Reserve Margin Projections for 1990 (Gigawatts)

Plant Type	Series C	No Early Oil Plant Retirement
Fossil Steam		
Coal	398.9	328.8
Oil	97.0	108.5
Natural Gas	58.3	46.8
Subtotal	554.2	484.1
Nuclear	145.8	145.2
Hydroelectirc	98.3	98.3
Combined Cycle	8.1	8.1
Combustion Turbine	67.7	88.6
New Technologies	5.1	5.3
Total Capacity	879.2	829.6
Peak Demand	646.3	647.0
Reserve Margin (percent)	36	28

Figure 9.6

The additional capacity in Series C is projected in response to economic trade-off in the model.

The final slide, please.

(Refer to Figure 9.7)

This slide compares the average price of electricity in the two scenarios. A lower average price of electricity of .2 to .3 mils per kilowatt hour occurs in the no early oil retirement case. The increased costs in Series C is due to revenue required from the additional new coal plants constructed.

MR. EYSTER: Over time, as the coal plants grow older, the relative price flips so that the present value over the entire life of the plants would, in fact, be less.

What we are seeing in 1990 is a short-term phenomenon. When you build the new power plants, the cost of electric is higher in the near term but will be lower in the later years.

MR. BOONIN: Are you using what Ms. O'Brien termed a levelized factor?

MR. EYSTER: That is not levelized.

MR. BOONIN: That's an instantaneous change?

MR. EYSTER: It is an estimate of the price in 1990.

MR. MYLANDER: Could you please explain the difference?

MR. EYSTER: There are two different sets of numbers that are calculated within the model. One is for decision-making as to what plant to build. The other one is the interaction with the demand model to establish what the electricity demand is. The difference is that in the price estimate we vintage the capital. The decision-making estimate is levelized. It is used to compare plants over the same period.

NATIONAL AVERAGE ELECTRICITY PRICES BY SECTOR

PROJECTIONS FOR 1990

(MILLS PER KWH, 1978 DOLLARS)

	SERIES C	NO EARLY OIL PLANT RETIREMENT
RESIDENTIAL	43.4	43.2
COMMERCIAL	43.5	43.3
INDUSTRIAL	31.7	31.4
NATIONAL AVERAGE	38.3	38.0

Figure 9.7

MR. BOONIN: So we have no idea, depending upon the vintaging of plants which are coming on line, coal versus oil in the substitute model, what worth that table has?

MR. FANARA: I think we might hold the questions for later. Thank you, Betsy.

Our next speaker will be Mr. Clark.

MR. CLARK: I'm only here to talk about the special problems of nuclear, of which there are many, or at least one big one that I can think of. The midterm forecasting system, because of its time horizon now through 1995, is influenced to a large extent for nuclear by the long lead times that are experienced for nuclear plant planning and construction.

So, we spend a great deal of time trying to make sure that we have some reasonable estimates for how fast things can move through the pipeline and become available for generating capacity.

And, the buzzword we use internally is "build limit." What we do for the modeling system is establish a lower limit that's based on plants that are either operating or under construction for which there would be probably no turn-back point, barring some congressional action. And also, establish an upper limit that's based on the maximum amount of capacity we think could move through the system and be available at the particular year that's being modeled.

So this establishes a range within which the model can make its economic choice. If it decides that nuclear is not cost-competitive with coal in a given region, it cannot build up to this maximum available. But it typically will not cancel a nuclear plant that's well into construction because of the sunk costs--costs that have already been expended.

The way we do it is to take a snapshot of all the nuclear projects we know about in the system today. This information is available from the

Nuclear Regulatory Commission and various industry journals. Then, we apply rules on the time durations it takes to get from one step to another-- the necessary steps in the sequence of events that occur. These time durations are typically empirically derived. That is, they're based on recent experience moving through the system. For the three different low, mid, and high scenarios reflect statistical deviation of this empirical determination.

Another aspect of what we, as the nuclear people, contribute to the midterm system, is an estimate of the construction costs of nuclear plants. We spend a great deal of time being consistent with the rest of electric power in terms of our initial assumptions.

The nuclear case typically starts with a plant design as incorporated into a modeling framework that reflects today's regulations. We have identified some 30 unresolved generic safety issues which we think could impact the cost of the plant. And the low, mid, and high supply scenarios reflect different assumptions about the resolution of those safety issues and how they impact the cost of the plant.

Our contribution, like I say, is in the area of construction costs of nuclear plants and limits (upper and lower) on the amount of nuclear capacity available for generation in a given year.

That's it. No slides.

MR. FANARA: Thank you, Dr. Clark.

Our next speaker will be Dr. Baughman, and he is our first invited discussant.

As you realize, the two previous speakers are from the Department of Energy.

Dr. Baughman?

DR. BAUGHMAN: Having been the recipient of this kind of scrutiny of one's work at one point in my life not too long ago, I must say it's a great pleasure to be up here with the shoe on the other foot. It's much easier to play the role of a critic than it is to do the initial work.

I have five or six points that I want to make about the analysis that has been done by EIA and reported in their annual report. I've read through the sections of the report dealing with electricity fairly carefully. I guess where I'd like to start is not in the chapter dealing with the mid-term electricity supply forecasts, but to look toward the characterization in the reporting of electricity parameters and other chapters.

The first think I would like to look at is the reporting of total utility capital expenditures. In the annual report, there is a range of capital expenditures reported for the 1979-1990 time period, inclusive of all years, of $276 billion to $327 billion. That is a range of $50 billion, or an uncertainty in cumulative expenditures over this time period of about 12 to 15 percent.

This turns out to be, on the average, about $4 to $5 billion a year, depending on how you want to calculate it, compared with 1978 capital expenditures of $33 billion.

The EIA in their report in several places--and this came through very clearly this morning in the nuclear discussion--does not treat the financing of the expansion of capacity as a matter for analysis in their calculations of plant expansion and their forecasts to the midterm. Completely neglected is the impact of state regulations of electricity pricing and its impact on the utilities' financial wherewithall to construct that new capacity.

Utility rates have generally been based on an average cost pricing, or embedded cost of service, concept. Historically, a major portion of the net revenue, that income that is provided as a return to capital, has been interest during construction, a non-cash income allowance. Because this non-cash income item is growing in proportion to total net revenues, the financial capacity of the utilities quite likely may not be consistent with the prices calculated in the report for the new capacity requirements indicated. This, when recent increased interest rates have made it even more difficult to finance new construction.

In all cases, and certainly for all the sensitivity studies as well as for the base case, the report needs to quality the forecasts that are presented with the statement that these are results subject to the assumption that financing is available. EIA is aware of this problem and, in fact, it is stated in places in the report, but I don't think completely enough. Correcting the problem could significantly impact the numbers presented in the report.

Another difficulty with the analysis relates to the state regulatory environment. It is the neglect of the difficulty in establishing the need for new capacity when seeking certification of need of new generating units from state utility commissions when 30 to 45 percent reserve margins are present. These are the reserve margins indicated in the series C mid-case growth forecast in the report.

You'll note the trend to increasing reserve margins. This is described as a result of the substitution of new coal capacity for existing oil and gas capacity.

Often it is the case that utilities seek certification of new plants based upon the arguments that they will have a more secure fuel supply from alternatives to oil and gas and that the new plants will be more economical. But, it's been my experience that shortly thereafter, when the utilities then go back to the commission to request an increase in rates, they need, in part, to justify the increase in rates by the cash flow problems the financing of the new plant poses.

It sounds inconsistent to want new plants for reasons of economy and then require higher rates to finance the new plant, even though it is not. Whether the rate increases will be forthcoming to allow the rise in reserve margins indicated in the EIA forecasts to happen is problematical.

The third point I want to make is that part of the charter of the electric utility franchise in all states, to my knowledge, is to supply all reasonable demands for service reliably and at low costs. I would like to focus upon the issue of reliability.

I think reliability is given too little attention in the administrator's annual report. The EIA states that unpredictable events such as an oil embargo, a nuclear moratorium, severe weather or drought, or an extended coal strike would cause deviations from the projections it presents.

This is on page 266 of Volume 3. I did find that, in fact, a nuclear moratorium scenario was presented in the nuclear chapter, but not in the electric utilities chapter. But further, I would assert that at least two of these events are probably much more likely today than a week ago, and I think all have a significant non-zero probability.

These non-zero probabilities, in my opinion, have as great as or possibly even greater impact on the reliability with which electricity is supplied than the conventional notions of reserve margins or loss of load probabilities calculated from forced outage rates of plants on line and possible deviations in load.

I think the concern with prolonged supply disruptions, in fact, is a very large concern in the minds of the utility planners. I'm not sure that the utilities have figured out quite how to deal with this analytically in their own analyses of expansion alternatives. But, I think it is apparent that this set of concerns would motivate a supply mix that affords maximum flexibility. This is because there is some benefit to reliability of having an alternative, even though it may be high in cost. This concept is not incorporated in the analyses that go into the administrator's annual report.

Let me summarize before going on. All three of the aforementioned problems, that of financing, that of getting certifications from state commissions for new plants that need to be added in the face of high reserve margins, and the effects on reliability of the uncertainty of fuel supply, I think, imply a set of capacity additions for the electric utilities sector that may be somewhat less than even the electric utilities have suggested that they plan to have available in the future. I also think the risk averse posture that utility planners are required by charter to adopt is not properly incorporated into the EIA models, nor its analysis. In order to do this, the EIA models would have to be changed to incorporate both the societal costs of not being able to meet demand with an adequate supply of electricity as well as the possibility in their analytical framework of exhibiting the results of a disequilibrium. As presently structured, the model forces an equilibrium.

Now let us move on to further problems. Another criticism--this is a fourth criticism--is the absence of account taken of the different rates of escalation of fuel prices for alternative plant types in comparing plant costs in the capacity expansion logic. There is a calculation of levelized capital costs done but, to my knowledge, there is not any counterpart calculation done for fuel cost. There are cases where fuel prices escalate at different rates relative to each other and different from the overall rate of inflation. If EIA used a life cycle cost calculated from a levelized fuel cost over the life of the plant, it might be somewhat different than if only the current period prices were used in that calculation. This is particularly important in the capacity expansion logic and perhaps would influence the relative choice between plants in the results presented by EIA.

My final criticism is the lack of full attention given to maintenance scheduling and the use of an annual load duration curve in the calculation of production costs. To my knowledge, the plants are characterized by only a maximum capacity factor without reference to whether or not the scheduling of maintenance is possible in the periods of year that the maintenance can be completed. Maintenance is normally scheduled in the spring and fall when the demands placed on the capacity are somewhat less than the total installed.

It is possible to have adequate reserve margins in terms of your annual reserve margin tabulation, but not have enough capacity in the off-peak periods to schedule the required maintenance of capacity that is installed in the system. As a result, it is possible to experience shortages even under the condition of seemingly adequate reserve margins.

This is a problem that is not easy to deal with when an annual load duration curve is used. The problem would be aggravated in the cases with increased load factors.

The problem is certainly more significant under the conditions of lower reserve margins than is present in most of the scenarios that the EIA runs. However, there might be alternative cases, such as the nuclear moratorium scenario reported in the nuclear energy section, where the impact could be significant.

Well, I'm going to stop here and turn it over to the next speaker.

MR. FANARA: Thank you. Our next speaker will be Mr. Jerry Karaganis.

MR. KARAGANIS: Well, I'd like to start off by complimenting the Department of Energy on a very nice work aspect. I think each year we're seeing both improved forecasts and what I consider a high quality documentation and presentation of the forecast.

But, I also think things are going to get a lot tougher in the forecasting business and DOE has considerable challenge, I think, in dealing with the new realities of reduced nuclear, and the increased significance of conservation, which in the past they've been able to avoid because we had forecasts of significant economic growth, at least in the near term.

What I am saying is you just can't separate electricity from the economics of the country. And, I think over the past two years EIA has forecasted economic growth too high in the midterm. As a result, energy forecasts have been too high.

One of the nice fallouts of high energy forecasts is everybody gets a nice piece of the pie. You don't have to model any of the problems.

This year, if you look at the new Wharton forecasts of the long term and I believe also DRI, you'll see much lower GNP growth rates out in the next decade. Correspondingly, I feel that there will be reduced growth rates in all forms of energy.

So, let me focus on where I think the big problem in the electricity portion of the DOE model is. And that is basically modeling load. That's what electricity is all about. The representation of load in the past has been fixed. And, given what we see today, that is going to change.

I think annual load duration curves have seen their day. And, I think that a simple mechanism for reducing the growth and peak are not sufficient to capture the interaction between electricity and economic growth.

I would second Dr. Baughman's comments that the electric utility industry, as an industry, is not properly modeled. It's more of an engineering approach than a comprehensive look at the role of electricity in the near and long term.

Uncertainty is one dimension. Utilities have to plan for it. They do not have unlimited finances. They have now perhaps a much narrower range of choices for generation.

I think dynamics has always been a problem. It's difficult and tedious to look at what is really happening over time. I think the snapshot approach is limited for examining what the real world problems are. I also concur that reliability is somewhat ignored. It is just set aside.

And, I think, if nuclear is limited and if coal doesn't come on line as it continues to face more and more environmental constraints, reliability will become a significant issue.

I suppose it isn't the intent of the DOE forecast to offer solutions. I would say that when you are done with a forecast, you'd like to believe that it's a future, although not fact, is workable, and that the entities that are existing in that future have a chance to survive and operate under normal business rules.

So, in summary, I think a lot of these problems will collapse back upon looking at energy growth and particularly electricity growth, both the demand and the energy.

Someone is going to have to use that model, that change.

In closing, I'd like to offer a suggestion because of this changing and uncertain world that we're facing. I think that DOE should afford other people an opportunity to comment on their pre-publication of their graphs and, perhaps, even participate within the constratins of the charter given to them by Congress in forecasts.

Thank you.

MR. FANARA: Thank you, Jerry.

At this point, we'll turn to replies from the invited discussants.

Jerry Eyster, would you like to begin?

MR. EYSTER: I think we had some very good comments here. And fortunately, I think that actions are being taken in most of the areas to do something about them. They are not new. They are ones that we are very much aware of, and they have concerned us.

Taking Dr. Baughman's points, he spoke of not taking capital expenditure requirements into account, the neglect of the state regulatory commissions, and the omission of analyses of reliability problems. He suggested that we need to model the industry instead of just the physical engineering conversion process. Such modeling is the focus of some work that is now being done by the Coal and Electric Power Analysis Division. A contractor for the Division, in essence, is bringing in the state regulatory commission decision process into the MEFS system.

The regulatory process is a very complex one. We are exploring various options. One option would be to decouple the capacity expansion decision from the equilibrium model. This would have the MEFS model solve for a world where the decisions have already been made on the capital expansion.

The model would work with what was anticipated to be needed in 1990 or 1995, based on assumptions made in 1985.

This approach would allow us to analyze reliability issues because we could posit scenarios where the state regulatory commissions do not allow adequate rate increases or do not allow the building of capacity except to meet incremental demand.

With the new structure an analyst could look at disequilibrium scenarios. Such disequilibrium was not modeled in the main frame scenarios in the annual report. The "no early retirement" sensitivity analysis, discussed earlier, was our attempt to broach this area. We posited what another decision-making framework might be using the modeling tools we had at the time.

We analyzed what happens if you go to the commissions and they say, "You are not going to be allowed to add the capacity, even though you can make rational, economic arguments that it is in the interest of our consumers in the long term to build that capacity. We will not grant the rate increases."

Steps are being taken to improve the modeling of regulatory behavior.

I will now deal with several miscellaneous issues. Coal is already levelized. Nuclear is levelized. Oil is the only fuel that is not explicitly levelized. By not levelizing oil prices, given that most of the forecasts show its price increasing in real terms, we underestimate the economic attractiveness of replacing oil-fired capacity.

As for plant maintenance scheduling, the capacity factors that are used are based on historical experience. There are implicit, within that historical experience, aspects of what are the levels of operation that one can expect from this type of equipment during the year.

Along with the assumed improvement in the load factor was an increase in reserve margin. Work that was done for EPRI indicated that as the load factor goes up, the reserve margin must increase to retain the same reliability. This was dialed into the assumptions in the model. So, providing for adequate maintenance time was addressed.

Coming back to reliability, if you don't have the nuclear capacity, if you can't build the coal, and if the demand is increasing faster than your expanding capacity, you've got problems.

The analysis for the annual report did not present such problems. The world that we were looking at was pre-Three Mile Island. The nuclear numbers were, I think, very fair estimates. I do not think there has been any strong criticism that we were being either extremely pessimistic or extremely optimistic.

There was no indication that we could not build the coal-fired capacity called for in the projections. There was concern that the various permitting processes were complex. There were other concerns about whether utilities would replace the oil capacity. No one was saying that the coal-fired capacity could not be built. Thus, within the projections that we developed, we had adequate reserve margins.

So reliability was not a critical element of what we were looking at. We probably should have posited some disequilibrium solutions and analyzed scenarios farther from our main frame. However, for the set of problems that we examined, the focus of the analysis was not on reliability. It was on coal-fired capacity and the replacement of oil in the utility sector.

It is clear that the demand is there to build the capacity. Can it be built? This was the issue that we identified. This would be an area where having comments from the utility industry would have been helpful in developing some of the scenarios, particularly in terms of disequilibrium. Certainly if all goes wrong, then we've got problems.

Finally, there is the issue of economic growth and electricity growth. I find it very interesting that EIA and its predecessor organizations in FEA has largely been projecting low electricity growths for the past five years. Utility industry projections have been very slow to respond to high oil prices and increased conservation.

Over time, the industry forecast, reported through the National Electric Reliability Council or through EEI, has declined from 7.5 percent to 5.8 percent. This latest forecast is at the high end of EIA's growth rate range through 1990.

In fact, we have slowly been merging. The industry forecast has been coming down towards where EIA consistently has been projecting electricity growth to be.

I think the EIA's modeling of electricity demand has provided a rather consistent story. When I hear concern voiced about reliability, it's typically by the industry saying that it is projecting 5.8 percent growth, but it really believes that the growth rate will be higher.

There is concern about what the industry really thinks is going to happen. Are they saying that the growth is going to be high but they are jiggering the estimates reported by NERC so that they do not have to build capacity? Or, are they saying that these estimates are high and they really believe that demand growth is going to be lower? There is disagreement here.

The bottom line is that I think the industry has various stories. The story that the EIA has put together is a reasonably consistent one, is internally consistent and has been consistent over time. It has provided a base for analysis of various policies and looked at the capability of the industry to expand. I think the EIA should be reasonably proud of the modeling in this area.

Certainly there are problems in all the things we do. But I think there has been a consistency there that has led the analytic community.

MR. FANARA: Dr. Baughman, would you want to reply to that?

DR. BAUGHMAN: I have just a couple of comments. I guess, first of all, I should say that many of the comments that I made were recommendations for future reports.

I think the one thing that comes out of this, and I think this is part of what Jerry was saying, too, is that the analyses reported give the impression of much less uncertainty in the future outlook for electricity supply and demand than I think is really present.

And, to the extent that they portray the world with plus and minus 5 percent or plus and minus 10 percent uncertainty, I think they are misleading. Misleading even to the point of steering us away from thinking about what is the real problem. And that is one of uncertainty.

My recommendation is that, in future years, the EIA analyses cover more extremes in terms of both supply alternatives and demand alternatives.

I'd like to respond now also to three other points.

You said that the coal price used in the expansion calculations was indeed a levelized coal price because the coal price is constant, in constant dollars. But that is, in fact, an output of the model and not necessarily required as an input.

Thus, one could conceive of scenarios where the price would change and escalate in real terms. The nuclear moratorium case is an example. There are cases where the conditions of the base case won't hold. When this is the case, the problem would be present.

You also indicate that you used the results of an EPRI study to dial in a relationship between load factor increases and reserve margin. I think that's just fine if you did. However, the report states that the increase in reserve margins is because of substitution of coal for oil and natural gas plants, and makes no statement at all about increasing requirements for reserve margin.

Finally, you pointed out that Three Mile Island was a recent event--if anything, it made greater the range of uncertainty--and that shortages and other reliability considerations that I talked about as possibilities were not so likely six months ago or nine months ago.

I agree that that's true. I think there is also good precedent in the history of DOE and its predecessor organization to, in fact, broaden its capability for analysis to more extremes and to also build in the capability to analyze the situation of disequilibrium.

I happen to know, for example, that in 1975-1976 the Federal Energy Administration sought the services of an outside contractor to do some analyses of the effect of the California nuclear power plants' initiative.

One of the reasons was because the then PIES model did not simulate disequilibrium. Thus, the effects of passage of that initiative possibly could not have been captured in the then FEA modeling apparatus.

That was four years ago and the problem has arisen again. So there certainly is a historical precedent. And, if some response had been made to build the model apparatus, the inability to deal with it would not still be present.

Thank you.

MR. FANARA: Thank you. Jerry, do you have some response?

MR. KARAGANIS: Yes, I have a few comments.

First of all, if I am correct, when I compare our forecast with the EIA's, there's very close agreement. This makes me suspect that not too much electricity forecasting is taking place in the midterm model.

The point that I am trying to make is that if you forecast high you can accommodate everybody. That is the nice part of it. You stay out of trouble.

And, what we are facing is a world where we expand our economic and energy system through pain. It is a growth through pain!

The only way that things will get done is when someone is finally tired of suffering either a gas line or the issuance of rationing cards. The Thomas Alva Edison coupon is, I'm sure, on the horizon, probably somewhere in the building over on Constitution Avenue, or wherever.

So, the point is that it is a responsibility of EIA to tighten up the forecast and just see how good you are in calculating the smaller pie. Just see how good your modeling system is, so when the National Coal Association comes by, you say sorry but this is the way we see it. You're one of the bigger losers in this game.

I know the output of such an exercise will be to really improve your methodology. You know that you have to begin to then face the question of whether you have modeled an industry properly or you have just some grand supply allocation mechanism there that works just by conception without any reason or rhyme.

Thank you.

MR. FANARA: Thank you, Jerry.

At this point, we'll entertain questions from the floor. And, I would ask that you please direct your questions to one specific speaker.

MR. PEARSON: John Pearson from EIA again.

Jerry, what exactly are you getting at? Do you want us to clamp down on capacity or what?

MR. KARAGANIS: No, no. I want you to model lower economic growth.

MR. PEARSON: That's easy. We do that anyway.

MR. KARAGANIS: What I'm saying is your forecasts of oil accommodate the oil industry. Your forecasts of gas accommodate the gas industry. Your forecasts of electricity accommodate the electric utility industry. And, your forecasts of coal accommodate the coal industry.

And, to some degree, you're beginning to accommodate the conservation industry. Okay?

I'm saying the realities are you are not going to be able to accommodate all those people.

By going ahead and coming up with some sort of consensus forecast that accommodates them all is not really the service I think your organization was intended to provide to the public.

MR. EYSTER: I didn't realize we accommodated anyone.

MR. PEARSON: Neither did I.

MR. FANARA: Yes?

MR. BOONIN: I am with the Pennsylvania Public Utility Commission. I have a question for Ms. O'Brien.

You stated that you had base case or baseline reserve margins for the various regions?

MS. O'BRIEN: Yes.

MR. BOONIN: What did you do for each region? You used your 10 regions like the rest of the system?

What do you use for Region 3?

MS. O'BRIEN: It's 20 percent as a base number. But, as Jerry was explaining, it's modified with the load factor improvement.

So if we're assuming a one percent improvement for the load factor in 1985, it would be 21 percent.

MR. BOONIN: It's only modified for load factor improvements and not for outage improvements, increased scrubbers, relaxed environmental restrictions, or whatever else may come along?

MS. O'BRIEN: No. The only change is in regions with hydro-use. It's increased because we're assuming an average water flow. And, during adverse years, we felt they needed a higher reserve. Reserve hasn't been looked at closely because, recently, the growth in demand has declined.

MR. BOONIN: You're just taking a standard, okay.

MR. FANARA: Yes?

MR. FAN: I am Shou-Shan Fan from the Department of Energy, FERC. I have a question for Ms. O'Brien.

Do you analyze the demand by region or just by the lump sum?

MS. O'BRIEN: It is by region. The model minimizes the overall costs for each region.

MR. FANARA: That was the question?

MR. FAN: Do you analyze the demand and the supply by region?

MS. O'BRIEN: Yes.

MR. FANARA: Any other questions?

MR. PEARSON: I guess I should ask this of Marty or Jerry. Do you have any evidence that peak load pricing will influence this the way we're suggesting, the 1, 3, and 5? Or is this too direct a question?

MR. KARAGANIS: It depends upon what you think peak load pricing is, and what it's going to impact. If it's going to shut things down over the full duration of the load curve, you know, of the peak portion, then it's going to impact it. There is a good likelihood that it would just impact on energy and leave the total demand on capacity right there.

So I say it's fairly uncertain, I think.

DR. BAUGHMAN: My response to that is that, first of all, we have the British experience and the French experience. And certainly, there was some shift in load there. I don't know what you imply by your peak load pricing. If you change the seasonal peak load prices, you would think that might have some minor impact.

For the time of day rates you would expect to shift the time at which the load occurs during the day. You talk about rate reform and different kinds of pricing schemes in the report. But, I didn't see specifically what you had referred to in terms of seasonal versus time of day rates or how you were actually implementing it.

MR. KARAGANIS: Could I get back to my point of annual load duration curve versus much more detail under load duration curve.

If you're going to try to model reality, you have got to get out there and change that annual load duration curve.

MS. O'BRIEN: I'd like to comment on that, if I can.

A study was just completed by Energy Management Associates of Atlanta estimating the impact of an annual load duration curve and scheduled maintenance modeled as a reduction in the capacity factor on the projections of fuels consumed.

The annual load duration curve wouldn't be changed for the 1979 annual report, but it may be revised for the 1980 annual report.

MR. FANARA: Any other questions?

If not, I'd like to thank each of the invited speakers: Jerry Karaganis, Martin Baughman, Betsy O'Brien, and Mr. Clark.

And, I thank everyone for attending.

(Whereupon, at 11:45 a.m., the conference ended.)

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CHAPTER 10

ENERGY USES

SPEAKERS:

Mr. Thomas J. Mooney, Energy Information Administration
Mr. C. Patrick Bell, Pace Company
Mr. John Castellani, National Association of Manufacturers
Mr. Ronald Eash, Chicago Area Transportation Study
Mr. R. B. Guerin, Shell Oil Company

The meeting was reconvened at 1:05 p.m.

DR. ALT: Welcome back to the second afternoon of our Symposium to Review EIA's 1978 Annual Report to Congress, Volume Three. This afternoon we will have two sessions.

The first session is Energy Uses and the second session is Energy Impacts. As you can gather, we are more or less following the actual structure of the Annual Report. That is the way the symposium was set up.

As our first speaker on energy uses, we have somebody representing the EIA point of view. That is Mr. Thomas Mooney, who is Senior Analyst with DOE/EIA.

MR. MOONEY: I would like to talk about changes in the energy demand projections between the 1977 and the 1978 Annual Report to Congress.

We can have some discussions at the end of my presentation about the assumptions underlying these projections and why they changed between these two reports.

There are three sources of change. These would be from the supply side; the demand side and changes in the integration model.

The presentation which I'm going to go through will only discuss the demand side. On the demand side, we are basically going to see five sources of changes.

The macro effects in the forecasts we are using in the '77 Annual Report to Congress, which is properly titled, I believe, "The Administrator's Report to Congress." There is a macro effect and a price effect in that the world oil price paths we used in the two reports were quite different.

There was also a data update in that when the report was done previously, preliminary figures for the year '76 and '77 were used. In this year's report, we used the actual '76 and '77 figures. These make quite a bit of difference in the report, because we basically used a benchmark process in which the model was callibrated to actually yield the '77 value; then the forecast took off from this value.

The only other change between the two reports concerns conservation assumptions. In the 1977 report we have a far higher level of conservation than what was shown previously. May I have the slide?

(See Table 10.1)

Basically, the table has been set up to show two things. One is the amount of change in the two projected years, '85 and '90; in between the '77 annual report and the '78 annual report. The changes are summarized for the major consumers at the bottom, and in between on lines 12 through 40 we analyze the change in terms of the five factors which I just outlined.

Taking a look, the major changes that showed up, I believe, were in the industrial sector, and it was approximately 1.5 quads and 2.2 quads in 1985 and 1990, respectively. And the major reason for this change really dealt with a data base revision in between the preliminary and final numbers in the benchmarking process.

And the other point accounting for this difference is the macroeconomic projections because there was no difference in the model structure and there were some small price effects.

And this is basically my opinion.

Moving from the industrial sector, we go into the residential.

SOURCES OF CHANGE BETWEEN 1977 AND 1978 AAR
ENERGY DEMAND PROJECTIONS (10E10 BTU'S)

MAJOR FACTORS IN PROJECTION DIFFERENCES	1985 AMOUNT OF CHANGE CONTRIBUTED	1985 PERCENT OF TOTAL CHANGE	1990 AMOUNT OF CHANGE CONTRIBUTED	1990 PERCENT OF TOTAL CHANGE
Model Changes	-171	-4.6	661	12.6
Residential	-891	-23.9	-813	-15.5
Commercial	49	1.3	105	2.0
Industrial	0	0.0	0	0.0
Transportation	670	18.0	1369	26.1
Macroeconomic Projections	-497	-13.4	-1415	-26.9
Residential	13	0.3	-8	-0.1
Commercial	40	1.1	-121	-2.3
Industrial	-731	-19.7	-981	-18.7
Transportation	181	4.9	-305	-5.8
Energy Price Assumptions	-611	-16.4	-1520	-28.9
Residential	-113	-3.0	-61	-1.2
Commercial	5	0.1	-33	-0.6
Industrial	-59	-1.6	-44	-0.8
Transportation	-444	-11.9	-1383	-26.3
Conservation Projections	-1624	-43.7	-1953	-37.2
Residential	-433	-11.6	-522	-9.9
Commercial	-233	-6.3	-119	-2.3
Industrial	70	1.9	183	3.5
Transportation	-1038	-27.9	-1495	-28.4
Historical Base Data	-862	-23.2	-1038	-19.8
Residential	59	1.6	69	1.3
Commercial	-122	-3.3	-38	-0.7
Industrial	-881	-23.7	-1303	-24.8
Transportation	82	2.2	234	4.4
Total Change, Actual	-3718	-100.0	-5243	-100.0
Residential	-1364	-36.7	-1336	-25.4
Commercial	-251	-6.7	-213	-4.1
Industrial	-1590	-42.8	-2203	-41.9
Transportation	-514	-13.8	-1501	-28.6
Total Changes Shown	-3765	-101.3	-5265	-100.2
Net Change Due to Factor Interaction	47	1.3	12	0.2

Table 10.1

We see quite a bit of change in there, mostly for the same reasons. But in the residential sector some of the differences between the two projections are due to conservation effects reflecting assumptions about appliance efficiency standards and building standards.

The commercial sector between the two years has a very small amount of change shown. As a matter of fact, it's almost the same for both '85 and '90. If we go down through the commercial sector, we can find out that most of the change is evenly distributed with no particular overall contribution, except maybe from the data base. And in reference to the data base, it probably also brings out another factor, which I'm not sure how it's handled in other energy models, in that we usually use a process of benchmarking to ensure that when the model is run it actually replicates the base year in which we're taking off from.

Rather than using benchmarking, a lot of macro models and energy models use to add factors to insure that the model actually replicates the data in the historical period.

I think this is something we're going to have to examine and come to a decision whether they should continue to be used or dropped completely from the forecasts.

Transportation: One of the major changes in transportation is the conservation effect. The difference in conservation reflects two things; assumed in the year's projections that basically the auto efficiency standards would be implemented and there is a shift out of gasoline cars into diesels of approximately -- I believe -- starting by '85, we assume it reaches 9 percent of the new cars produced, and it remains constant from there out into the end of the projection period.

This covers everything I wanted to outline. I think the process was to hold questions until the end, but I think it might be better, if you have any questions right now, that we address them at this point. And perhaps, then, after the other speakers have had a chance to comment on my presentation or make presentations of their own, we can return to what they are saying.

DR. ALT: Are there any questions from the audience, or would you rather reserve your questions?

(No response.)

Okay, at this time, let me introduce the first speaker from the non-EIA sector. And that is Mr. C. Patrick Bell, who is Senior Consultant and Manager of the Pace Energy Study, and obviously is with the Pace Company.

MR. BELL: I think I'll stand out here.

First, for those of you not familiar with the Pace Company, we have been involved in energy forecasting for approximately ten years.

There has been substantial discussion about methodology in some of the earlier sessions. I'll talk briefly about our methodology, but I would like to spend most of my time comparing how we see the outlook for energy with the annual report.

We employ a wide range of models, both macro and micromodels, in our energy analyses.

We do utilize the Data Resource econometric model; however, we have modified it substantially based on our own input, primarily for various energy parameters.

If there are questions concerning our methodology as we go - because there has been so much interest in it earlier today - I would be happy to answer any questions.

But as such, let's get on and compare what we see as the outlook for U.S. energy.

If I could have the first slide -

(See Figure 10.1)

Can everybody see that?

What this chart shows is three forecasts that we have published over the last six years. Each succeeding forecast has been revised downward. The one factor that has had the biggest impact on downward revision of these forecasts is the price and the availability of international crude oil. The top line, which was published in 1973, showed a level of 115 quads by 1985. We don't think that is going to happen until well after 1990; and that is reasonably consistent with what the annual report says.

The top line, over the green area, is the forecast we published pre-Iran, and the bottom line is our latest forecast that incorporates our revised thinking on not only what Iran will be producing, but also what we think the total world oil outlook will be over the next 20 years.

We don't think that the world supply of oil is much going to exceed a level of about 62 million barrels per day by the end of the century. This is consistent with Saudi Arabia producing, at most, 10 million barrels per day, with total OPEC production not rising much above 32 million barrels per day.

This is one factor that is a major difference between the annual report numbers and what we see. I know the annual report 1990 oil production from OPEC is about 40 million barrels per day, and the total world oil production approaches 72 or 73 million barrels per

U.S. ENERGY CONSUMPTION

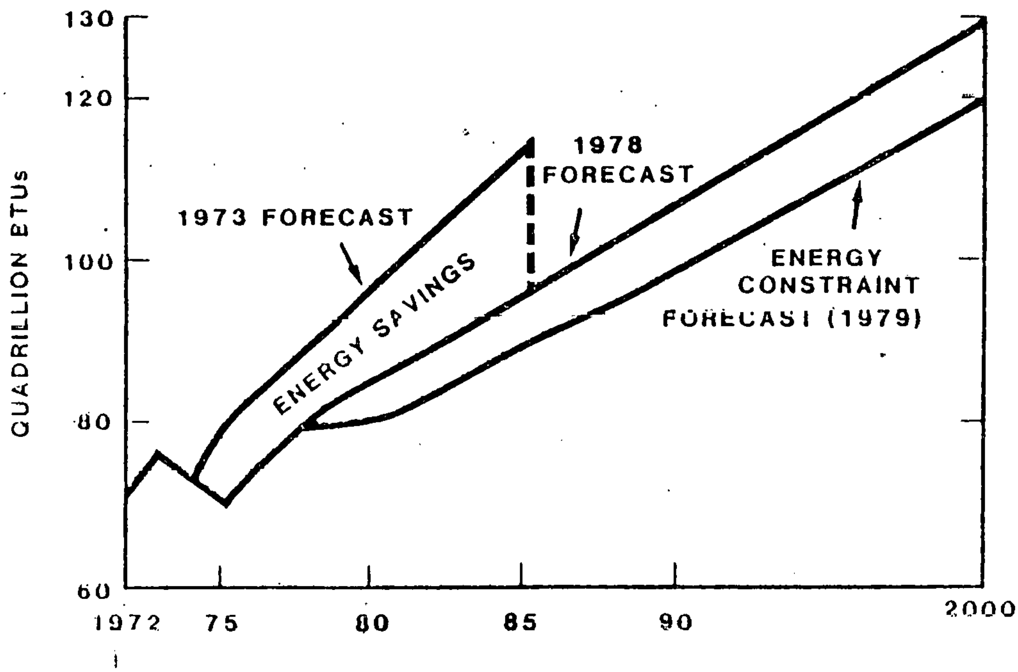

Figure 10.1

day by 1995.

We see total energy by the year 2000 at about 120 million quads in the United States. We developed this forecast in a manner that is somewhat different from our previous forecasts. The way we have done all of our previous forecasts is to calculate energy demand given an outlook for economic growth.

Based on that demand and an assessment of conservation, domestic energy supplies, and energy price, we determine how much imported oil is required to balance supply and demand.

In our latest analysis, we have started with an assessment of international oil supply and have calculated how much energy the United States can expect, given economic growth and population growth throughout the world.

We then back-calculated where the available energy will be consumed in the United States: either in the Household/Commercial, Transportation, or the Industrial Sectors.

The overall implication of our analysis is that the world and U.S. will experience continuing escalating price increases. We see prices of crude oil escalating 2 to 3 percent per year throughout the century.

There will be a much stronger trend towards conservation. This is what I would like to talk about now; first some history and then how we see future conservation.

(See Figure 10.2)

This chart shows an index of energy consumption for each consuming sector and also total U.S. energy in the United States relative to the 1973 level. Total U.S. energy consumption per unit GNP has improved

ENERGY CONSERVATION

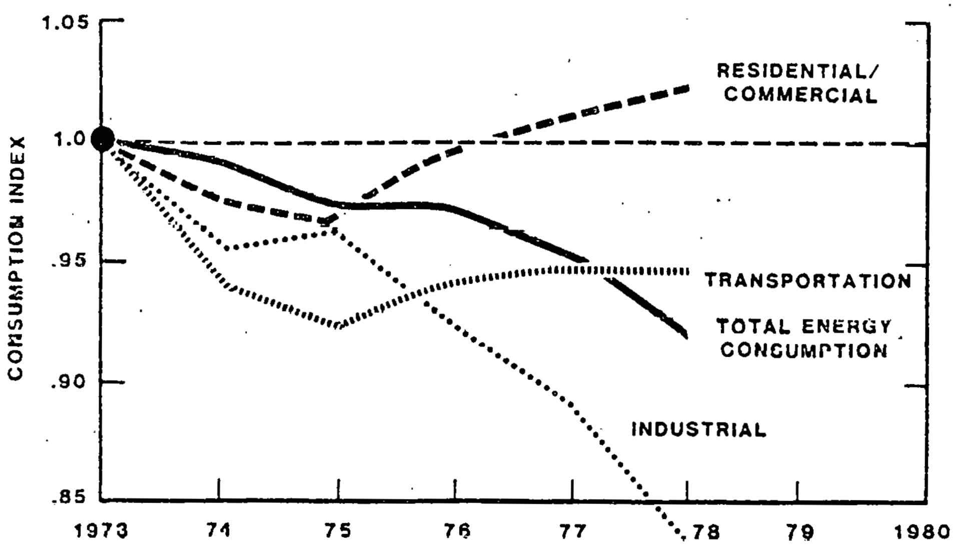

Figure 10.2

since the 1973 oil embargo. The area making the greatest contribution has been the Industrial Sector, the blue line.

Energy consumption in the Industrial Sector in 1978 per unit output was about 16 to 17 percent lower than it was in 1973. Just to tell you the units of this chart, total energy is Btu per GNP; Residential/ Commercial is Btu per household; Transportation is Btu per car; and the Industrial is Btu per unit of Federal Reserve Board Index of Industrial Production.

The Transportation Sector also made improvements over the 1974-1975 time period. A lot of this, though, was the result of constrained supplies. The supply was simply not available and/or people perceived that it was not available. This is very similar to the condition we have today regarding gasoline. Also, there was a big recession which resulted in an overall slowdown in the economy and resulted in reduced driving. As conditions improved, the level of unit energy consumption in the Transportation Sector increased, but did not go back to the level before 1973 because of higher prices. Also, more fuel efficient automobiles had begun to penetrate the marketplace.

The Residential and Household/Commercial Sectors - we group these two together - showed some improvement in 1974 and 1975, but actually increased after 1976. There are two factors that accounted for the large part of this: first, we had some very cold winters over the 1976/1977 and 1977/1978 time period; second, there was an increasing penetration of electricity in the Household/Commercial Sector, largely because of the lack of availability of natural gas.

Electricity as a percent of total energy consumer in the sector increased from 45 to 48 percent over the 1973-1978 time period. If you correct for these two factors, the green line would drop to a factor of about .95 in 1978.

Okay, how do we see the future? First, talking about the Industrial Sector, we think there will be continued improvements in the level of energy consumed.

We expect the ratio to decline from a level of about .85 to about .75 by the end of the century. Now that is not nearly the same degree of improvement as has already occurred. We think that most of the easy improvements have taken place. Consumers, particularly in the intrastate gas markets, which responded to high prices after the 1973 embargo, have made substantial energy saving investments.

Even though there are going to be improvements in the industry technology, future improvements will be limited by capital stock turnover.

Industrial consumers are not simply going to write off investment - unless the tax laws are changed considerably - because there's a new idea. Just like you or I won't buy a new automobile because our old one is two years old and doesn't get as good gas mileage.

The Transportation Sector will be the sector that shows the most significant improvement. We show the energy consumption ratio declining to about a .8 ratio by 2000, and most of this takes place over the mid-1980 time period, as the EPA-mandated standards come into effect. We believe that there will be additional improvement beyond the EPA 27.5 miles per gallon requirement. We have forecast that new car mileage efficiencies will increase to about 30 miles per gallon by 1980.

The basic implication of limited supplies of energy to the Household/Commercial Sector will be poorer lifestyles. People won't stop buying houses, but houses will be smaller; and there will be more multi-family dwellings.

People are going to better insulate the existing housing stock. At the same time, if you look at the ratio, we have projected that the ratio increases - actually increases up to about a 1.05 level by 2000. And the reason is the degree of electrification. We believe the degree of electrification will increase from about 48 percent today to about 61 percent by the end of the century.

So as a result, gross energy per unit will continue to increase, while net energy will decrease due to the inefficiency of electricity generation.

Let me have the next slide.

(See Table 10.2)

This summarizes some of the implications that I just talked about; the Industrial Sector will continue to spend money for improving energy consumption. Cars are going to be smaller. There will be a trend towards more mass transit. Our assumptions on percent diesel penetration are roughly the same, at about the nine percent level.

The trend toward mass transit will also help support strong growth in diesel fuel.

Just some other comments regarding the demands in each sector: we're a little lower than the Series C case for total energy demand by about five quads in 1990.

IMPLICATIONS

- **INDUSTRIAL SECTOR**

  CAPITAL EXPENDITURES SUBSTITUTE FOR ENERGY CONSUMPTION

- **TRANSPORTATION SECTOR**

  SMALLER CARS

  MORE MASS TRANSIT

- **HOUSEHOLD/COMMERCIAL**

  MULTI-FAMILY DWELLINGS

  INSULATION

  THERMOSTAT SETTINGS

Table 10.2

Most of the difference appears to be in the Industrial Sector. Our forecasts for the Transportation Sector and the Household/Commercial are within five percent of the Series C projections. I'm not sure why there is a discrepancy in the Industrial Sector. It may be that we have made some different assumptions in allocating the electric losses in the Utility Power Sector to the consuming sectors.

This was basically all I was going to talk about in terms of the demand side. From a positive standpoint, we believe the Energy Tax Act will definitely improve the level of conservation.

As far as the Energy Security Corporation, there are some positive aspects from the standpoints of promoting mass transit. We have rolled some optimism into that.

Overall, however, we believe that additional incentives are going to be required in terms of spurring conservation, particularly in the Industrial Sector. The alternative is going to be even higher prices than we have forecast and increasing shortage potential in terms of supplies. We feel very strongly that the dependence on crude oil, the growth and the supply of international crude oil will play a major role on future energy consumption. We'll be lucky to see a level of about 62 million barrels per day by the end of the century.

That's all I have to say.

DR. TAKAYAMA: Do you assume any capital-labor complementarity at all or is this just an academic model?

MR. BELL: I'm not sure I understand your question.

DR. TAKAYAMA: If it's an academic argument, let us just forget about it.

DR. ALT: Thank you, Pat; I'm sure there will be some additional questions at the end.

We would now like to move on to the next speaker, representing the non-EIA points of view, and that is Mr. John Castellani, who is Vice President of Resources and Technology, National Association of Manufacturers.

MR. CASTELLANI: Thank you.

It's nice to hear such a nice pitch for industry before I get up here. I'm assuming I'm going to respond to the report and all the rest of it. I'm assuming everybody read the sucker. I didn't. I was hoping for the movie.

(Laughter.)

But I did read the section that related to industry.

A little bit of historical perspective: we finally got a little bit of EIA's attention. If you read last year's report, they had us going from 36 percent up to a total energy consumption in the United States of 45 percent in about a week and a half.

(Laughter.)

They said that industrial energy conservation had not started. We scratched our heads a little bit. Conservation, in fact started, -- the industrial sector has been the leading sector, as was pointed out.

I think we even outdo the federal government in terms of conservation in our own buildings. The questions is: Why? I'd like to take a look at the overall energy projections from a subjective standpoint and then talk about each fuel and talk about the projections that EIA has made for each fuel in the fuel mix.

It was pointed out -- and this is the number we're touting -- since 1973, which is as good a base year as any year you can pick, except during the embargo -- industrial energy consumption per unit of output has decreased such that the efficiency per unit of output has gone up between 16 and 17 percent.

Gross energy consumption between '73 and through the end of '78 in the industrial sector is relatively flat. It reflects what has been alluded to in the past, and that is the industrial sector is the most sensitive to price change in basic energy commodities. And we have done the things that have been attributed to us. And that is, we've done the housekeeping work; we've done the reinsulation, the retrofitting of processes to a certain extent to improve heat recovery.

Well, it has been alluded that we have done all that can be done. In the future, then we'll have to look at the basic process changes. I would point out that what we have done in the past was done in the context of $15 a barrel oil. In the context of $30 a barrel oil, there's a lot more housekeeping that we think can be done, a lot more improvement that can be made in the context of $40 or $50 or $60 per barrel of oil. I think the Joint Tax Committee now officially has us at about $64 a barrel by 1990 and up to $72 a barrel for oil in 1990. And there is a reflected increase in the other energy prices.

We deny at this stage that the industrial energy demand will grow at anywhere near the rate that the overall projection is from EIA, and that is at a rate of 3.2 percent. In terms of projecting what would happen, we do run into a point where we run out of housekeeping. And then you begin to look at the basic capital-intensive process changes that are necessary to increase efficiency by some sort of quantum leap and when they will come.

There are a number of projects -- DOE sponsored and private industry sponsored that look at some of the high energy intensive industries and the basic processes in which they consume energy and look at how they can be changed and the capital intensiveness of these projects.

We would expect that these types of projects will remain in the longer term -- that is, not until the late 1980's (for example, the direct reduction of aluminum and some of the basic coating changes in textiles) -- into the later 1980's, unless we can demonstrate that the more rapid introduction of these processes can be paid off within our hurdle rates, which means that you've got to get rates of return in the high technology, wholesale process changes, which are in the upper teens and low twenties. Right now, the basic hurdle rate is about 15 percent. And the hurdle rates that we apply to industrial energy conservation investments that are housekeeping retrofit are very low because these are low risk technologies. We will apply the very high ones to the basic process changes, and so we do not expect the quantum leap until the late 1980's when we have the basic technologies down, have eliminated some of the risk, and reduced the hurdle rate in conjunction with the elimination of the risk, and we see the higher prices that we anticipate in the future.

Now, with that -- and my argument already is involving retraction by EIA of their projections for the 1990-1995 time frame, at least in the C projections, the middle level projections -- let me talk about each individual fuel because that may be more important.

Industry used to make its decisions on an economic basis in terms of what fuel we would use. And really the overall energy consumption for any individual corporation was made on an economic basis. And that's why we responded to the higher prices. However, the decision making process in choosing each of the fuels, in a choice among all the fuels that are available, was being taken away from the accountant and given to the lobbyist.

And let me go through the kind of scenario and the kind of confusion that we're in and why we have difficulty in projecting the mix.

Let's take coal: that's easy; we have a lot of coal. Any of you who have missed it, we've got either 300 or 500 years of coal. Indeed, we have the Power Plant and Industrial Fuel Users Act of 1978, part of the famous National Energy Act, that mandates the use of coal. It also provides for a number of exemptions for coal. It provides exemptions when the costs substantially exceeds the cost of imported fuel oil. We have a little difference with the Department of Energy on what Congress meant by "substantially exceeds." They said 30 percent. We thought the wage-price guidelines of 5.75 was most appropriate.

(Laughter.)

But clearly Congress said in that we cannot use oil, we're making decisions in forcing you to use coal (and here I'm interpreting the Act) I'm not interpreting DOE's regulations, which I contend and we are contending in court don't bear any relationship to the Act, but that's a different story.

Here Congress is saying: we want to move toward coal and alternate fuel use and we're going to force you to move toward coal if it's not too expensive. Okay, so the normal economics of coal versus oil will work to some extent there and coal will become more attractive.

The second thing that Congress said was you will use coal in boilers over 100 million Btu an hour heat. But you won't use it if you can't meet environmental standards, and so there's an exemption for environmental standards.

Well, you look at the reasons why coal use is declining in industry and it is because it's been too expensive and because the environmental restrictions have been such that you can't burn it. And now we have an act that says you have to burn coal except if it's too expensive or environmental restrictions say you can't burn it.

(Laughtor.)

So the question is: will there be any great increase in coal use in industry? The answer is: I doubt it unless we have a fundamental change in the way we either establish and apply environmental restrictions or unless we have a fundamental change in the technology and the cost of the technology of cleaning up the various methods, the various ways that you can use coal. So that leaves coal.

EIA has a short-term, modest increase in coal use; we're going from something like 17 percent of the total mix to 25 percent by 1995. It may be a little high. It depends on whether or not we run into a paralysis where we can't use our most important or most abundant fuel and Congress wnats to make a decision like they made on the Energy Mobilization Board to push coal.

Natural gas: natural gas is my favorite topic. Depending on the time of year, which year, and who is Secretary of Energy, we either have a lot of natural gas and have to use it or we don't have enough.

Last year and for the last two and a half years, we have been so short of natural gas that all of the laws, the regulations that have been implemented by Congress and the Department of Energy have been aimed at getting industry off natural gas.

Therefore, it is easy to make a projection that says that natural gas is a dwindling resource; all the laws, all the regulations are designed through changes in curtailment priorities, changes in pricing structure, incremental pricing, to get industry off gas. The use of total natural gas use in this country will continue to decline.

That is fine. In fact that is what is going to occur unless something happens which we think will happen, and that is incremental pricing. Incremental pricing is designed to get industry off gas. It's designed to do it by getting the industrial sector to subsidize the residential, commercial and the agrucultural sectors. It also happens to subsidize the electric utility sector.

If we get off gas, and we're 40 percent of the load now, that means the rest of the folks who just heat their homes with gas in the winter are going to have to bear the burden of the transporation costs all year around. And we think that a couple of years of bearing the burden, seeing how expensive it is, Congress might have a different thought on incrementally pricing natural gas to industrial users. In fact yesterday two Congressmen cosponsored a bill that would remove Title II of the Natural Gas Policy Act and do away with incremental pricing: Rep. Preyer from North Carolina and Dave Stockman from Michigan. We expect a similar bill to be introduced in the Senate within the next couple of days. It probably won't come up until next year, but incremental pricing could, that is, the decision on incremental pricing could influence whether or not the industrial use of natural gas will remain constant or decrease to the extent that it's being projected to decrease.

Electricity is pretty easy. A lot of the electricity section will increase; we don't have any basic quarrel with EIA's projection on the portion of electricity used by industry; that is, the portion of the total energy mix.

However, it has been used to a large extent to replace natural gas. Where we can get enough improvement in efficiency through the use of electricity to offset the difference in cost. If gas is available, we probably won't use as much electricity. If oil is available, we won't use as much electricity. Without that availability, we will turn more and more to the use of electricity and more and more to the kind of techonologies that allow us to use it more efficiently.

I might add that the politics of the situation are the same way; although it didn't turn out to be mandatory, there is still a requirement for every state public utility commission under the Public Utility Regulatory Policies Act for 1978 that requires each and every state public utility commission to look at changes in basic electricity rates, all of which -- we're a little paranoid here -- but we believe are aimed at putting the burden on industry: lifeline rates, elimination of declining block rates; marginal cost pricing for industry only and not for the residential and commercial sectors; time of day rates, with which we have no argument; season rates. All of these we'll be happy to consider over the next two to three years, depending on which ones you're talking about.

Each public utility commission in each state in an evidentiary hearing must consider these pricing proposals, they are not required to adopt it. DOE is in there pitching now in these hearings that they do adopt some of these rate structures. If they do, they're aimed at raising the price of electricity to industry beyond the cost of service. They also could raise it beyond for other segments. If that happens, then it's going to be very difficult to increase the use of electricity and still remain competitive.

Now, our favorite: distillate and residual fuel oil: residual fuel oil is still about half the price of distillate? I'm going to have to have that checked. Anyone who is not using resid that has the capability to do so now should or probably they'll be fired by the purchasing managers. Distillate fuel oil has been traditionally used in space heating and boiler applications in industry. It is beginning to be used in some process applications. Where it is beginning to be used is primarily as a replacement for natural gas.

Well, if we don't have the gas, then we use distillate. If we don't have distillate fuel oil is about 240,000 barrels a day, I think now, in total industry - not including the utility sector.

Again, when it comes to handing out scarce supplies, industry is at the bottom of the ladder, and it's a situation we're used to. But I can't take an exception to EIA's projection of distillate use, which is a declining use, because I have no idea what the natural gas situation is going to be and what the overall supply situation is, although I have a guess.

Residual fuel oil seems to follow that trend in how much resid is available, how much you can use it in the boilers, and what the price differential is between that and distillate fuel oil. And right now it's pretty good.

To sum it all up: we no longer make the individual decisions on fuel mix on a purely economic basis because, as important as price is, now also is availability. It doesn't make any difference if you can use cheap gas if you can't get it. If it's expensive and available, we're willing to pay a reasonable premium.

But the politics of the situation will do more to dictate the mix or as much to dictate the mix of the fuels used within industry as the price. Total overall use will depend on price which has done a tremendous amount to dictate the use, and we expect we will continue to have them show a very small growth and total industrial energy consumption with continued improvement in efficiency in a standardized unit of output to a much greater degree than EIA is projecting.

With that I will stop talking, and we'll take questions, I guess, at the end.

DR. ALT: Thank you, John.

We would now like to have someone representing the transportation section, and along these lines I would like to introduce Mr. Ronald Eash who is a Transportation Analyst with the Chicago Area Transportation Study.

MR. EASH: Before I critique the transportation energy chapter (Chapter 20), I think it's important to understand that my viewpoint is that of someone whose primary interest is not energy, but whose primary interest is transportation. Sepcifically, it's the viewpoint of someone who has worked in a major local transportation planning instituition, a Metropolitan Planning Organization for the Chicago region.

Metropolitan Planning Organizations, MPO's as they normally are called, are designated by a governor of a state to do transporation planning for every metropolitan area of over 50,000 population. As a consequence of this legislative requirement, transportation planning is quite institutionalized across the country, and you will find the same kind of transportation planning activities taking place in every major metropolitan area. These planning activities are required in order to have federal funding participation in transportation improvements.

I'd also like to note that much of the discussion which I've heard the last two days gives me a feeling of deja-vu. Many of the comments which I've heard regarding the EIA models are similar to comments often made about the usefulness and responsiveness of the urban transportation planning models. These transportation models are very aggregate models like the energy models which have been discussed.

In response to these criticisms, there's been a divergent type of modeling activity in transportation planning using disaggregate models. By "disaggregate," I mean models which are based on individual household and individual firm behavior rather than the aggregate behavior of large populations or sectors of the economy. While I don't feel these models can be wholly endorsed, it is probably an approach which the people who are doing the energy analysis should investigate. And, there has been a great deal of literature published in the transportation field on these disaggregate models and their applications. This literature is a resource for both modelers and critiquers to explore.

A number of MPOs, including Chicago Area Transportation Study, are developing programs and procedures for calculating energy consumption in private and public transportation. The focus of our work, though, is to look at travel behavior in response to energy availability and pricing. This is quite different from the transportation viewpoint in the DOE/EIA Annual Report to Congress, which is concerned with petroleum pricing and avialability, and really doesn't show much interest in changed travel behavior or the impact upon local transportation improvement programs.

It is not surprising that an analyst with a background such as I have described finds the report's treatment of transportation very unsatisfying. This opinion persists even when the computational and programming problems of incorporating more behavioral types of models in a macromodel, such as the midterm energy forecasting model that is the focus of the transportation chapter, are readily admitted.

This critique attempts to point out some of the problems with the treatment of transportation in the midterm model. The organization of the critique is to look at the individual submodels that make up the midterm model. The transportation energy chapter discusses midterm projections of transportation energy use and transportation fuel prices. Use of the term "midterm" is in an economic sense, implying no major changes in technology, but some substitution of transportation fuels.

All of the projections, A through E, from the midterm model are variants of a common scenario; that is, a scenario which assumes the continued dominance of the highway mode, private automobiles and truck travel, and a changing vehicle fleet fuel efficiency caused by the introduction of more fuel efficient vehicles over time.

I want to discuss the three components of the midterm model in the following sequence:

1. the fuel conservation model;
2. highway vehicle-miles of travel, and
3. price elasticities of transportation fuels.

(See Table 10.3)

The first component of the midterm model is the fuel conservation calculations, and these estimate the average fuel efficiency of the vehicle fleet in future years. The second component is a highway travel demand model which attempts to predict vehicle-miles of travel in response to some economic indicators. And, the third subcomponent is the transportation fuel price elasticities.

I'd first like to look at the fuel consumption calculations and again indicate that these calculations are concerned with calculating the average vehicle fleet fuel consumption rate at a future year. These average fuel rates are quite difficult to compute, since they are predicated on the assumption that you can also predict a whole variety of other items including: the age distribution of the vehicle fleet, the distribution of model types within model year,

DISCUSSION OF THE THREE COMPONENTS OF THE MIDTERM MODEL

1. The fuel conservation model,
2. Highway vehicle-miles of travel, and
3. Price elasticities of transportation fuels.

Table 10.3

the model fuel consumption characteristics by model year, and how these fuel consumption characteristics change as the vehicle ages. Also included in these calculations, are the average vehicle-miles driven by a particular aged vehicle.

These calculations are about identical to the calculations that the transportation and environmental people have been running through for some time to compute emission rates for vehicle fleets. These emission rates are used to project emissions and air quality. So I really can't be to critical about these calculations, but just indicate that they are quite difficult to carry out. Also, the computations in the DOE/EIA report have one advantage over other work I've seen, in that they incorporate changes in vehicle retirement rates and vehicle purchase rates in response to income and employment levels.

Developing the model-year fuel consumption rates, remains a problem. The figures in the report are still tied to fuel consumption as measured by the USEPA through the EPA test-cycle driving profile. There has been a considerable debate about the validity of the USEPA procedure. Vehicles are tested on a dynamometer and not on the road. Also, the relevance of the driving cycle, how well it predicts an average driving profile, remains questionable. I'd like to suggest that while we have questions now, in the future we are likely to have even more serious doubts about the relevancy of the profile and the testing procedures.

First, I would like to show typical fuel consumption data used in transportation analyses. The first figure shows warm engine fuel consumption curves from a couple of different sources. The dashed linear lines represent arterial street fuel consumption, as developed by General Motors Labs several years ago. The solid lines are from a report called "<u>The Characteristics of Urban Transportation Systems</u>," which is published by the Urban Mass Transportation Administration and the Federal Highway Administration.

(See Figure 10.3)

The major thing I want to point out in these curves are the differences between the two sets of data. The dashed lines indicate that fuel consumption characteristics improve at higher speeds on arterial streets. The solid lines show that fuel consumption decays with increasing speeds on freeways and rural roads.

This shows the difference in character between urban and rural and between freeway and arterial street travel. Arterial streets are subject mainly to stop and go travel, interrupted traffic flow. Speed improves through the elmination of braking-acceleration cycles. Of course, braking-acceleration is where a large amount of fuel is consumer on arterial streets. So with increasing speed, you do have decreased fuel consumption.

On the other hand, on freeways and rural roads where traffic is freely flowing, you don't have the same kind of relationship in effect. As you increase speed, inherent resistence of the vehicle becomes more important, and this decays fuel consumption performance.

May I have the next slide.

(See Figure 10.4)

This slide, from some data developed by GM, shows cold engine performance. A cold engine performs far less efficiently than a warm engine, and over the intial portion of a trip there is a fuel

Typical Fuel Consumption Curves

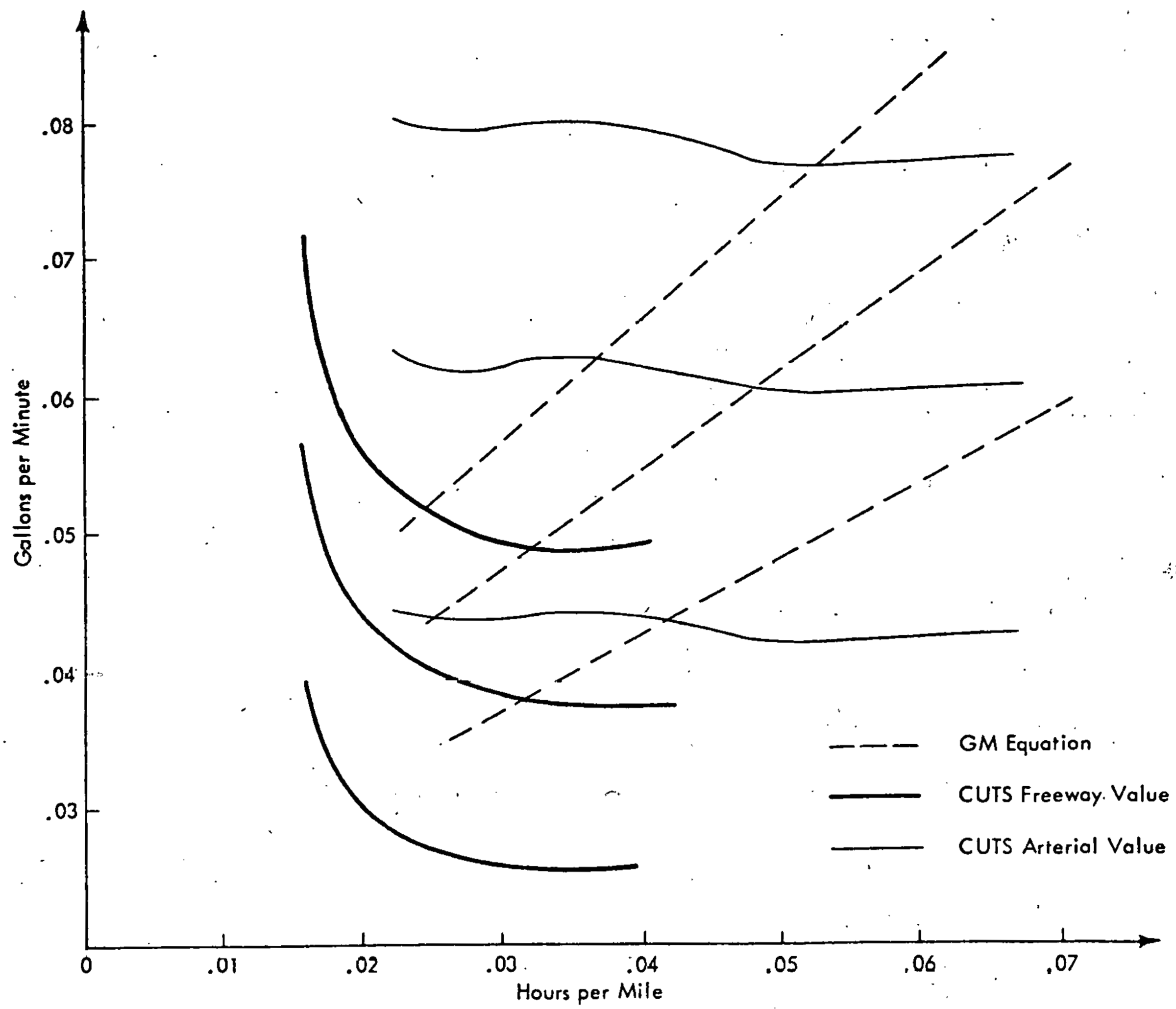

Figure 10.3

Cold Engine Excess Fuel Consumption

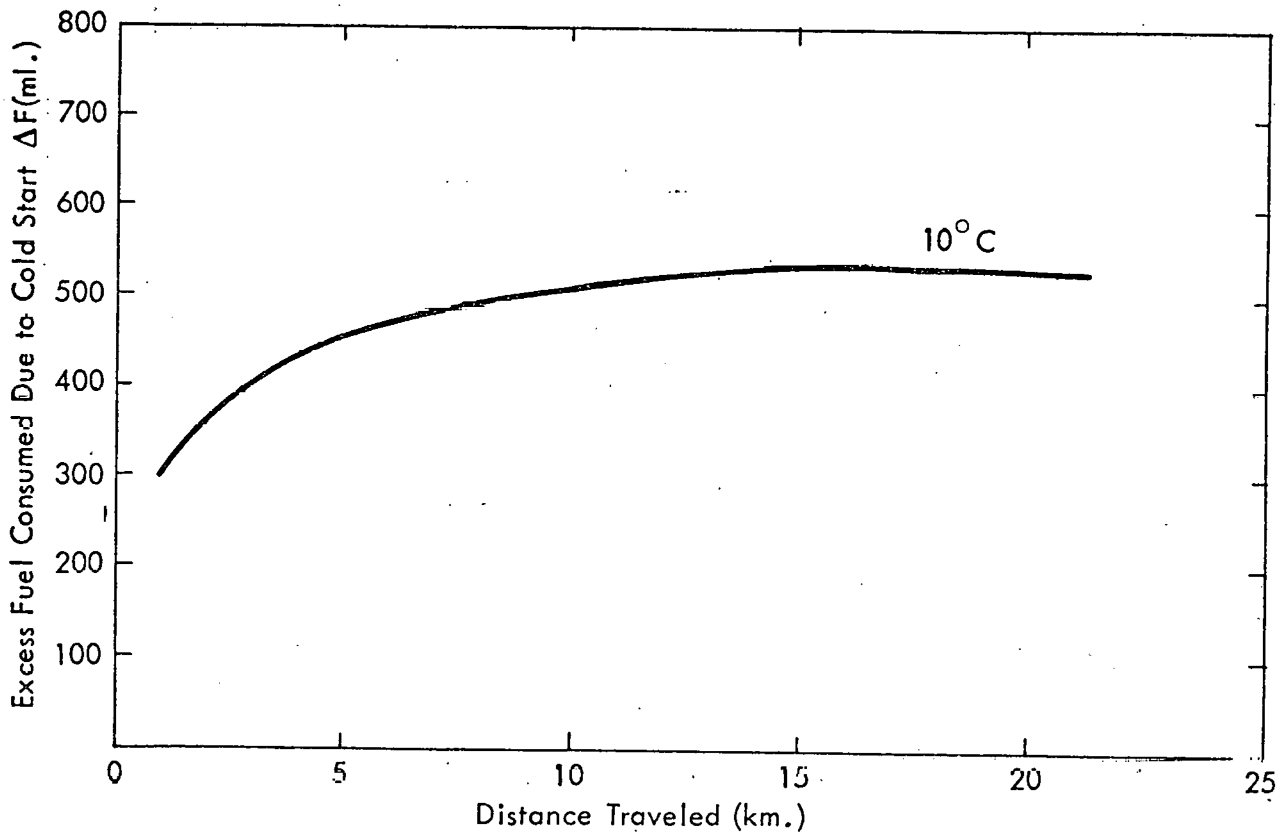

Figure 10.4

consumption penalty. This figure shows fuel consumption in excess of that for warm engine consumption. And after about 10 miles of driving, there is no longer any additional penalty paid. The engine is warmed up and fuel consumption agrees with the warm engine equations.

These two figures raise a number of questions with the DOE/EIA analyses. First of all, in the DOE/EIA analyses, there is no distinction between urban and rural, city and local travel. Yet it is clear from these consumption data that there are considerable differences between vehicle fuel consumption in rural and urban travel.

We would also anticipate that under future gasoline price increases, there might be some shift in the proportion of urban and rural travel because there are different amounts of discretionary travel occurring in rural and urban areas. Future gasoline price increases will discriminate against discretionary travel, so we would anticipate some shift in the proportion of highway travel toward rural.

This next slide shows a table from some data gathered in 1970 in a home interview survey and it shows a purpose breakdown of the number of trips and the number of person-miles which each trip type contributes in the region.

(See Table 10.4)

You can see in this table that the amount of social-recreational trip destinations and the amount of shopping trip destinations are nearly equal to the number of work trip destinations. The home

Table 10.4 1970 Weekday Person Trips, Person-Miles, and Trip Lengths in the Chicago Region.

Purpose To	Trips (1000's)	Percent	Person-Miles (1000's)	Percent	Average Trip Length (Miles)
Home	7,904	42.4	41,798	43.7	5.3
Work	2,770	14.9	18,519	19.4	6.7
Business Related to Work	580	3.1	4,276	4.5	7.4
Shop	2,324	12.5	6,955	7.3	3.0
School	678	3.6	2,097	2.2	3.1
Social/Recreational	2,560	13.8	14,560	15.2	5.7
Personal Business	1,224	6.6	5,486	5.7	4.5
Other	576	3.1	1,956	2.0	3.4
Total	18,616	100.0	95,647	100.0	5.1

destination trips are normally the reverse of the other trips, and these we are ignoring. But, the person-miles generated by the work trips are quite a bit larger than the shopping and the social-recreation person-miles because of the longer average trip lengths that are associated with work trips.

DR. TAKAYAMA: This is from Chicago?

DR. EASH: Yes.

The social-recreational and the shopping trip purposes tend to be more discretionary than the work trip. If we are faced with rising gasoline prices, which again discriminate against discretionary travel, very likely we'll have a greater proportion of work travel occurring in the vehicle-miles traveled in a region or in the country. From a transportation standpoint the major consequence of this shift is longer average trip lengths, and these longer trips tend to make greater use of higher class facilities. Again this implies that there should be some adjustment of the driving cycle, which is used for development of the average fuel consumption figures.

We would also expect that there would be a larger proportion of cold start travel, since the work trip generally takes place at the start of the day after the vehicle has been housed overnight, and resumed after the vehicle has been stored during the day. Therefore, there would be more cold start travel in the vehicle-miles traveled within the region.

DR. TAKAYAMA: Could you explain that category called "home."

MR. EASH: Okay. The purpose shown in the slide is the destination purpose, so these are all "to home" trips, and include work to home, shop to home, social-rec to home, etc. All the others are primarily from home trips; so basically they're home to work, home to shop, etc. That's why I said to ignore the home destination trips because they are approximately the other half of the picture.

DR. TAKAYAMA: Right.

PARTICIPANT: One is greater than the other.

MR. EASH: Which one is greater than the other? Some trips are not destined to home; some trips don't start from home either. But, the majority of trips have one end at home. You do have a lot of trouble gathering these home interview surveys. People are very reluctant to admit to certain kinds of trips.

(Laughter.)

I'd like to make a few comments on the second submodel, which is the vehicle-miles of travel calculation. As near as I can determine from the description in the documentation that is in the DOE/EIA report to Congress, this model uses some relationship between vehicle-miles traveled and economic indicators of disposable income, gasoline price, and employment levels. I would guess that this relationship was developed through a regression or other mathematical function fitting technique.

In transportation there are some problems with this particular approach. If the vehicle-miles dependent variable is fit to time series independent socioeconomic variables, then the resulting relationship reflects all the other socioeconomic changes during the period data on the independent variables were collected.

For transportation, this is critical because two things have occurred over the last two or three decades that have had a tremendous effect on urban highway travel. First, there is the migration to urban-suburban places and, secondly, the effect of highway construction programs which have taken place during this period. Both of these trends seem to be pretty well terminated.

In fact, it's becoming very difficult these days even to generate enough user tax revenues to maintain the existing highway physical plant. So it's very unlikely that there will be any additional highway construction at the level which we have experienced over the last 20 years, and any trend line or mathematical forecasting technique based on data from this period to predict travel demand should be used cautiously and considered very suspect.

This DOE/EIA approach also neglects how the highway network's performance is affected by travel demand. Over the last couple of decades, the massive highway construction programs have increased highway network capacity and also improved average travel speeds.

(See Table 10.5)

This next table will give you some idea of how highway travel speeds have changed over the last 20 years. These are airline distance journey speeds, but I think they are still a fair indication of what has happened over the period. This table is for the period 1956 to 1970, and is broken down by distance from downtown. That's what the ring designation indicates.

The important number to look at is the percent difference in average travel speeds. Speeds improved somewhat on the order of 20 percent over this period for the automobile mode. The next slide shows the same statistics for travel time.

(See Table 10.6)

Table 10.5 **Average Work Trip Travel Speed (mi/h) 1956-1970** in the Chicago Region.

AIRLINE JOURNEY SPEED

	AUTO			TRANSIT			TOTAL		
Ring	1956	1970	Percent Difference	1956	1970	Percent Difference	1956	1970	Percent Difference
0	12.8	15.3	19.5	11.7	13.1	12.0	11.9	13.7	15.1
1	11.4	14.5	27.1	8.9	11.1	24.8	10.0	12.7	27.0
2	10.4	13.2	26.9	6.7	7.5	11.9	8.8	11.2	27.3
3	10.4	12.1	16.4	6.6	7.1	7.6	8.9	10.5	18.0
4	11.4	12.5	13.6	7.0	6.5	-7.2	9.8	11.3	15.3
5	11.9	13.2	10.9	7.5	7.2	-4.0	11.0	12.3	11.8
6	13.7	14.5	5.8	8.5	9.3	9.4	12.8	14.1	10.1
7	16.0	17.2	7.5				15.3	17.0	11.1
TOTAL	11.7	14.1	20.5	9.0	10.5	16.7	10.5	12.8	22.0

Table 10.6 Average Work Trip Duration (min) 1956-1970 in the Chicago Region.

AVERAGE TRIP DURATION

	AUTO			TRANSIT			TOTAL		
Ring	1956	1970	Percent Difference	1956	1970	Percent Difference	1956	1970	Percent Difference
0	33.8	34.0	.6	44.1	46.9	6.3	41.9	42.5	1.4
1	30.3	32.1	5.9	43.4	46.8	7.8	36.6	38.1	4.1
2	26.4	28.1	6.4	38.8	47.9	23.4	30.6	33.3	8.8
3	25.3	26.3	3.9	37.4	41.5	10.9	29.0	29.8	2.7
4	22.8	24.5	7.5	38.7	38.8	.3	26.3	26.5	.8
5	24.0	25.0	4.2	44.0	45.9	4.3	26.7	26.8	.4
6	20.1	22.6	12.4	44.5	56.5	27.0	22.0	23.8	8.2
7	18.7	20.9	11.8	45.2	66.9	32.5	20.0	21.4	7.0
TOTAL	24.6	25.1	2.0	41.6	45.8	10.1	30.3	29.6	-.7

You see that even though average speeds have increased, the average time which is spent in travel has changed very little over this period. These are work trips, incidentially. The result of all the highway construction has been increased travel speeds, increased distances traveled, but not any additional expenditure of time for the dominant work trip.

We interpret this as meaning individuals in households have a pretty constant time budget for travel. If we accept fixed travel time budgets and a relatively constant or possible decaying highway network performance, we might expect some equilibrium between network performance and highway travel demand would soon be reached.

CATS' predictions of future vehicle-miles of travel - and I think they may be optimistic for the Chicago region - include about a 1 percent increase per year in vehicle-miles traveled. Other additional travel demand will be soaked up by improved communication, substitution of modes where available, and some gradual relocation of employment, shopping, and home sites to reduce travel requirements.

DR. TAKAYAMA: The increasing price of gasoline could change the future vehicle-miles of travel drastically downward, as people move toward the city, closer to work.

MR. EASH: It's not clear that is the case. There have been recent studies which have shown rather than a movement back to a central place, what may occur is a nucleation around minor urban centers - formation of suburban centers around major cities.

This is under debate right now. There are a lot of people who are pro-central city; they argue we're going to have higher gasoline prices and will move back to the city. It is not apparent that will happen. What appears more likely are greater densities in some of the suburban areas. You see this around Washington, where you have major shopping centers which have residential and working areas developing around them.

I want to make a few comments on the last component of the midterm model; the fuel price elasticities.

(See Table 10.7)

This slide shows the gasoline price elasticities from the DOE/EIA report to Congress. These figures are the percentage change in vehicle-miles traveled per percent change in gasoline price. A 1 percent increase in gasoline price in 1995 results in an approximately .6 percent drop in vehicle-miles traveled. As this table shows, the elasticities are projected to decrease through 1995.

From a transportation standpoint, the use of a single elasticity for all type of trips doesn't adequately explain the responses of individuals to gasoline price changes. Different trip movements and different trip purposes have historically shown widely varying responses to modal cost changes, illustrated in this next slide.

(See Table 10.8)

These figures are auto cost elasticities from a modal choice model which we use at CATS, segmented by trip purpose. These elasticities are the percentage change in mode split in favor of the auto mode, given a percentage increase in auto trip cost. The important thing to pick off this slide is how different the elasticities are for different kinds of trips.

The home to work CBD directed trips have an elasticity 10 times the elasticity associated with non-CBD home-work trips. This reflects

Table 10.7 DOE Midterm Analysis Gasoline Price Elasticities

Year	Gasoline Price Elasticity
1985	-0.3708
1990	-0.5122
1995	-0.6106

Table 10.8 Auto Cost Elasticities From CATS Mode Split Model

Trip Type	Auto Cost Elasticity
Home-Work CBD	-1.19
Home-Work Non-CBD	-0.0906
Non-Work	-0.107

the availability of public transportation as an alternative mode for the CBD directed trips. They are subtantially more negatively elastic than non-work CBD travel and non-work, non-CBD travel.

DR. TAKAYAMA: Your concept of elasticity is quite different from the DOE/EIA definition.

MR. EASH: I pointed out that the two elasticities are not comparable, but the mode split values indicate that you might expect different elasticities for different purposes and different trip destinations. I don't want to compare them numerically, but merely to show that you would expect the range of elasticity to be substantial.

The major recommendation I would offer -- and I think anybody in my position would offer -- is that the midterm forecasting model needs to have a more realistic transportation sector built into it. The model should reflect the performance of all transporation modes.

One possible solution is to run the macromodel iteratively with the behavioral transportation models, cycle it back and forth, using the fuel pricing and availability outputs from the macromodel as inputs to the more behavioral transportation models. Next, taking the behavioral results from the transportation models and feeding them back into another iteration of the macromodel.

We also feel that the midterm analysis focuses too much on vehicle technology without considering any of the behavioral travel consequences of fuel price increases and availability.

Particular transportation issues which the report should address are: (1) to what extent discretionary travel is suppressed, (2) what kinds of shifts in travel mode might we anticipate, and (3) what sort of impacts on trip destinations might be expected? Eventually, the analyses will have to take into account land use change impacts, different locational choices of residences and work places in response to transport fuel prices and availability.

There also needs to be an improved dialog between the national planning agencies and local planning agencies. Local agencies are in need of the output from the national agencies' work. These local agencies have to predict travel demand and carry out planning activities with some agreed upon gasoline pricing and availability scenarios consistent, with the national DOE analyses.

The national planning agencies might also benefit from some of the material which the Metropolitan Planning Organizations are developing to estimate responses to these fuel price changes.

Thank you.

DR. ALT: Thank you, Ron.

When Professor Norland and I were organizing the slate of speakers, we came to the sudden realization that we had failed to give representation to the oil companies. And this would certainly be an abrupt turn-around because now we are asking the oil companies to dish out criticism instead of being the recipient of it.

Along those lines, we have invited Mr. R. B. Guerin, who is a senior staff economist with the Shell Oil Company.

MR. GUERIN: As a bit of background, I work for Shell Oil Company's Corporate Planning function in the Energy Forecasting Department. This work has been going on for about 20 years and it is used as the basis for company forward planning. About 20 years ago, Shell went public with some of our work and I see that some of our data, along with other companies, has been used as a basis for comparisons with the DOE forecast. I have been involved in this work for sometime and during this period have reviewed most of the energy reports which emanated from Washington. Most of the previous ones, I believe, had decided on what the answer should be before the report was written. This recent document is encouraging and is a step in the right direction. We obviously don't agree with everying in it, but a sense of objectivity comes across in this document which has been missing in the past. I would give it high marks.

I would like to make one suggestion concerning scenarios. When you deal with the scenaric approach in a business planning context or in policy-making, you can confuse the planners with too many options. The way we in Shell have resolved this is to go to a maximum of three scenarios. Business planners want the most likely case and while we can tell them there is no most likely case, they will pick the middle projection as the base line. Additionally, they would like an upper and lower limit to the base line plans. We have found that business plannners can handle three scenarios and that they will use them as a base line, and an upper and lower limit. Additional scenarios are just not read. I get the impression that DOE is going in this direction. One of the exercises that we in Shell just completed was a scenaric approach to the future using as one scenario what we call the "Carter Cap" or what happens if in 1985 we are resticted to importing a maximum of 8.5 million barrels per day. What are the effects on the economy and the distribution system then? We hope

DOE is working on this problem.

Our Base Case Scenario now shows an energy growth of less than 2% per year through 1990, which is less than we indicated previously. Most other forecasters are coming out with the same lower projections. One problem that we haven't solved and to our knowledge no one else has solved, is how far you can reduce energy consumption without affecting the economy. You can always plot and extrapolate GNP/energy relationships, but we think this is a meaningless exercise. There is obviously some energy growth level where in the short term, economic disruptive effects appear. This effect requires more study.

I was asked to comment generally on the Commercial, Residential and Industrial portions of this report. I have always been somewhat amused during my forecasting experience that most people enjoy forecasting and the models that go with these forecasts. They love to forecast supply, to look at the international scene -- such as what is Iran doing today or what is Saudi Arabia going to do 20 years down the road -- and on the demand side, everyone knows, or thinks he knows, a lot about transportation and there is certainly a lot of data available. We know a lot about residences; everyone lives in a home, and there is data available. We know a lot about electricity use and, again, there are many statistics. But, when we talk about the Commercial and the Industrial sectors, which together comprise over 40% of our energy end-use, we should realize that we know very little about them at all. I noticed that DOE separated the Residential and Commercial markets. I am not criticizing them for their attempt, although I would like to know where they got their base line statistics, because frankly, we don't think they exist for some of the commercial sectors, and we believe at the moment that there is no way you can define the separation of the residential and commercial markets. So far as the Residential methodology goes, I see no problem with their approach, but I do question, of course, some of their assumptions and the effects of conservation.

In the Commercial market, where you are talking about a diversity of energy demands such as hospital, apartment houses, etc., you are not really talking about one market, but a number of different demand segments that are going to react differently, and though we hate to ask for more statistics, since we always complain about filling out more forms, I do believe we have no other choice in this matter if we really want to do any kind of an adequate forecast in these markets.

Generally, our forecast of the two markets is a little higher than DOE's, but not significantly so. Obviously, you have a geographic disaggregation problem to be considered since you have air conditioning use in the southern section of the country, different electric tariff structures and the problem of electric use in large apartment houses where they are taking out the master meter. Other changes such as the lifeline rates in California which benefit the residential user tend to increase electricity and, of course, the elimination of the master meter would tend to depress the electricity use.

When determining what fuels are going to be used in these markets, the basic input is a forecast of gas supplies. Our recent forecast is somewhat different than our previous forecast in that we show slightly more total gas available to the U.S. This is basically due to expected tax credits and gas price decontrol, which we think is going to drive out additional unconventional gas, particularly from tight sands. What this means is that we think the Residential and Commercial and

Industrial markets will be using more gas than we expected in the past. One of the problems we now have is how the expected magnitude of the conversion of oil to gas and possibly to electricity is going to be handled.

Now, let's turn to the industrial market demands which are even a bigger mess statistically. Our basic methodology in Shell is to project the Federal Reserve Board Index of production and compute the energy required based on a projection of energy use per production index. We project these indices using the DRI Economic Model after developing many of our own inputs. These projections are to the four-digit Standard Industrial Classification code. If you plot the production index versus energy, you see that it has been improving for many years and it is hard to decide why this is so. It certainly wasn't the cost of fuel, which as you know has historically not grown in real terms. Recently, they are increasing faster in real dollars and affects the value-added as well as the cost of materials. The reason for this historical improvement in energy efficiency is obviously process changes, new machinery, but perhaps some statistical problems. Another problem in forecasting the Industrial Market is that you are trying to forecast the energy use of approximately 22 major industrial classifications.

We did a study a few years back analyzing the numbers that were reported for Industrial energy use in the Census Bureau reports and the Bureau of Mines. The best agreement we were able to get after much adjustment between the Census Bureau numbers and the Bureau of Mines was within 3%.

One significant fact of industrial energy requirements is that six industrial users account for 85% of the heat and power portion of the industrial energy use; that is, Primary Metals, Petroleum, Chemicals, Stone & Clay, Paper, and Food. While this appears to be encouraging, the problem here is that even with these major energy users, the reporting statistics are not all that they should be. The primary metals industry reports on a yearly basis what they use, as does Petroleum. The Chemical industry has some statistics, but there is a problem of separating the energy that is used for feedstocks versus heat and power. Stone and Clay, Paper and Food industries have not in the past reported on their energy use by type of fuel. So, another problem is not only in the total market statistics, but the disaggregation of these statistics into the SIC codes.

One small section usually included in the industrial sector is raw material use is lubes, road oils, and petrochemical feedstocks, which we project separately. The heat and power section of the industrial market is comprised of boiler fuel, cooking coal, electric use and process fuels. An additional problem is the boiler inventory. To our knowledge, this does not exist. I believe the EIA is trying to develop the boiler inventory, but we don't know the extent of their results so far. We need to know boiler size by SIC code as well as the convertibility between gas, oil and perhaps coal.

We don't forsee much more coal going into the industrial market because of the boiler fuel switching problem. We do project more gas as your report shows. And then we have a problem with electricity. We are pessimistic on the co-generation potential. There has been a lot of publicity on co-generation and you can define it many different ways, but in essence I would say it's using excess steam. You may use that in the plant or you could sell it to a utility grid. The economics don't seem to be there. We've discussed this within our own company and the utilities around the Gulf and in the West. Unless it's a real special application or you run a real sloppy operation, co-generation doesn't really pay off. I won't say that is so 100 percent of the time, but we really don't expect much co-generation to come on.

Our general forecast for the industrial market is below EIA's; we have it growing only at about 1.4 percent per year between '78 and '90. But I didn't come prepared to give you our forecasts, I cam prepared to criticize EIA.

And my criticism is really that you've done the best job possible with what you have. I would like to emphasize that I don't agree with all their findings, but you seem to have considered everything.

DR. ALT: Thank you, Mr. Guerin. I'm sure Tom purposely kept his introductory remarks brief so he could respond.

Tom?

MR. MOONEY: I guess the first thing I'll do is I'll say I'm not going to say anything else about our industrial forecast.

But what I would like to say -- talk about is first of all the problem with the industrial numbers.

I think the present statistics collected both by trade associations and by EIA, which used building category definitions, are wholly inadequate for any kind of realistic modeling.

What I would like to have collected would be two digit SIC detail in the residential building categories and commercial building categories and industrial building categories.

And I don't know how long it's going to take to get this in. As Clopper Almon told me -- he wrote a report, collecting utility information, which was put into the record five years ago; he made the same recommendations and five years later nothing has been done. I hope eventually we'll be able to have a more positive response than that.

Where do we get our residential and commercial numbers? The numbers are basically building categories and they come from data collected by the utilities themselves, so that there is a little bit of weakness in them in that you are dealing with categories as opposed to establishments. And you're also dealing with average price as opposed to marginal price on which decision making should be based, according to economic theory.

Okay. On transportation, I think I misheard a comment on the transportation, so correct me if I'm wrong. You said you would like to have more cooperation between EIA and the regional transportation people. And the other part that I believe I heard is it's because you would like to have your work consistent with ours. I would object to that because if it's inconsistent, it probably means you know something we don't.

(Laughter.)

And this is the only way we are going to get feedback. There probably should be a better forum for reviewing what work has been done on a regional basis in transportation, but I have some problems with some of your suggestions, mostly because I think they would involve doubling our staff if we went to a complete urban-rural breakout with intermodal shifts. I can see our office growing to around 150 people.

But it is a worthwhile comment. The only thing I would like to comment on in here is that in reference to test-cycle driving profiles, we do not actually use the EPA standards. They are reduced for the on-the-road experience which EPA has found by calling the cars back approximately one year later and evaluating them.

In the industrial sector there's a question concerning some of the assumptions we used in modeling, particulary when we're referring to what is the significant cost difference. 5.7 and 30 percent are clearly quite a bit different. The only thing I would like to say is I wish you well with your court case, and if you win it, you can be sure we'll have 5.7 next year.

(Laughter.)

DR. ALT: Thank you, Tom.

Any responses from our panel?

MR. CASTELLANI: Yes. I would like to address one point that was raised by both Tom -- and it's always the planner's dream. I used to be a planner, so I speak with some identity to that. And that is information, particularly from the industrial segment. And those of you who are not familiar with the industrial information gathering abilities now there are programs that now exist, other than the MA-100's, through the Department there is a mandatroy and voluntary reporting program by what used to by the 50 top energy consuming industries in the 10 most intensive SIC codes. An now it is expanded to 20 SIC codes aimed at collecting information from any corporation which consumes more than a trillion BTU in a major energy consuming industry, which is defined in the 20 SIC codes, the twentieth of which is miscellaneous manufacturing. So it does cover just about everything.

That program is done through third parties, as was mentioned. It was done through trade associations; some of the industries hire an outside consultant, and it is done as just a measure of energy efficiency over a base unit of measurement of production, which varies because you can't do pounds of product output. It may be useful for the chemical industry, it is not very useful for the mainframe aircraft industry.

Energy consumption doesn't bear any relation to that. So it is a contant thing, it is a constant figure that varies between all of the SIC codes that report, and it's a constant unit for each code and it is a measurement of performance against a goal.

Now, that is attacked as being wholly inadequate, and I'm sympathetic to those people who do these kinds of projections. They need a lot more information. But there are basically two problems in gathering more information. First, information is gathered by SIC code, and if we can make anything clearer it is that we don't operate our plants by SIC code.

Now, this is one of the biggest myths since the relative benefits of co-generation that was already alluded to. We cannot break central utility operations in multifaceted plants out by SIC code. There is just not a meter at the end of the steam line that says: so much is going to 22 and so much is going to 28.

So if you want energy consumption by SIC code, there -- you're going to get it by the best estimate that the engineer can make in filling it out. And sometimes that best estimate comes from what all strategic planners know as the license plate method. You just look out in the parking lot and say, well, we'll pick the blue Chevy. And that's 546197. That's how much is going to the SIC code. It is difficult because we don't operate our plants that way.

MR. MOONEY: Yes, but John, I don't want to interrrupt your talk, but basically the classification of an establishment into a primary or secondary classification, is based upon what product contributes the major proportion of profits or its dollar value of shipments. Now --

MR. CASTELLANI: But that's not necessarily directly related to what product contributes to or consumes the most energy.

MR. MOONEY: I know. However, if we're going to have a reporting bias, we're going to have a reporting bias for the issue you raised. We're not going to have a reporting bias for the simple reason that we're trying to match SIC establishment and economic data with billing category information which in a lot of cases doesn't even correspond to industrial type activity. That's the reason why I think we should go to SIC codes.

MR. CASTELLANI: Okay, That also points out the dilemma -- and we spent a lot of time trying to find out a better reporting method. We can't take it past the two digit SIC codes. There was an attempt based on some legislation in the past year to force it to a four digit SIC code basis, and it became totally meaningless. But there is still that uncertainty because the categorization of the plant versus dollar sales or value added may not be consistent with the categorization of the plant in terms of energy consumer in each type of process.

The second problem is a political problem in gathering more information, and that is that this information is extremely valuable, competitive information and is highly proprietary. And we have been extremely reluctant to send it in to the Department of Energy or anyone else, for that matter, because of its value.

We have had problems with this type of information in the past; for example, in a boiler survey under ESECA, the Energy Supply and Environmental Coordination Act of '75, a boilder survey that was done and the reporting requirements that were set up under ESECA -- one type of information -- there was one person found not even filing a Freedom of Information Act, but for a major automobile manufacturer it ended up that the Department of Energy or FEA, in this case, announced the anticipation of construction in 1981 of a major plant, and that was very valuable to the other manufacturers. So we have a problem with that.

We also under the Freedom of Information Act read the energy consumption per pound of output for about 25 companies in the pulp and paper industry, all of which were very interested to see other people's data.

Now, if you look at some of the Freedom of Information Act requests, a lot of them are one company trying to find out what another company has filed. This type of collection of data, if it is truly worthwhile and is necessary to do accurate projections of energy consumption patterns in the future, has to be collected in a manner that protects the proprietary nature of the data; not only protects it from what we contend that DOE would do with it in the policy making procedures, but also protects it from industry because of its value as a competitor -- competitively valuable information. And with that, I'll leave those two points.

DR. ALT: Okay. Thank you, John. Any more comments? Ron?

MR. EASH: I want to emphasize my comments on the tie-in of the analysis to the EPA cycle. My concern was that this driving cycle used by EPA is likely not relevant under future driving conditions, future pricing, and fuel availability. It is not whether the EPA figure is plus or minus one or two miles; it is how relevant the whole process is and whether the driving pattern will adjust in the future. In the future, we may have to use different driving profiles to replicate the kind of driving behavior which is likely to occur.

The other point I would like to make is about cooperation between local and national planning agencies, and I want to stress the type of problem we have by just citing one example. To evaluate any future transportation facility improvement, agencies are forced to try to reduce many of the consequences of the facility into dollar terms. So one thing we need is some consensus dollar value of gasoline savings which we can use in evaluating future transportation facilities. This indicates the type of problem we have on the local level in responding to national work. If we have a wide range of national forecasts, what do we use at the local level to evaluate projects?

PARTICIPANT: Management wants a most likely value. They don't want summaries, but they do want summaries. So, do you --

MR. EASH: Most public and private agencies are, moving closer together.

DR. TAKAYAMA: A most true statement.

DR. ALT: Thank you. Any more comments from the panel?

(Negative response.)

Are there any questions from the floor? John?

PARTICIPANT: I'd like to know why co-generation is a myth.

MR. GUERIN: I didn't say it was a myth. I meant the expectation of a great growth in co-generation is a myth.

PARTICIPANT: If it's not a myth in Europe, why is it a myth here?

MR. GUERIN: The growth, I think, is a myth. Our economic studies show it to be not viable. Plus, you have the regulatory problems associated with the electric utility.

PARTICIPANT: When you say the future, are you limiting your comment to 1990?

MR. GUERIN: At the moment, yes.

PARTICIPANT: That's a different story, isn't it?

MR. GUERIN: I'm talking about 1990.

PARTICIPANT: Could I just follow up and ask a question?

DR. ALT: If you would speak up.

PARTICIPANT: Mr. Castellani, you talked a great deal about the industrial sector, but you didn't make any comment about co-generation. I don't know if the association has looked beyond the time frame mentioned, particularly if -- let me just qualify that. Mr. Guerin said, quite correctly, the co-generation problem is a problem of accepting excess generation. If that is the case, then maybe industrial parks would facilitate that.

MR. CASTELLANI: We spent most of the last year looking at co-generation because it was the vogue just prior to syn fuels, so you have to respond to both.

(Laughter.)

-- co-generation is something that is vaguely defined. First of all, you must understand the definition. I think the definition was already well given. There is a lot of co-generation that has been going on since the early 1900s for people using heat recovery generators. or back pressure steam trubines and using the steam as processing, driving compressors.

When you look at the barriers to co-generation; well, you don't necessarily have to make electricity and so you're limited by your steam needs in the plant.

Many times, when you're talking about large industrial steam turbines or you're talking about a combustion turbine, a gas turbine, the amount of horsepower that you need to drive compressors or other process equipment compared to the vast amount of steam that you will make in that kind of situation, you really have trouble finding a place to use all of the steam.

Now, when you're talking about electricity, you have additional problems. The problems are two-fold.

First are the economics in what are the effects of the economics? Electricity co-generation is not a retrofit technology. You can't go in through an existing grid system where they have 38 percent reserve margin and say, "Hey fellows, do you want to buy some off peak power?" They don't want it. Then from the industrial perspective, and it has always been perceived by Congress and by policy makers that the policy was that big bad utilities wouldn't give us fair backup rates; which is true, because you can't get a fair backup rate when you're coming and saying, "I'm willing to sell you 150 megawatts of off-peak power which youdon't need," but your bargain in this agreement is that should my system ever go down, you've got to make sure you get me that 150 megawatts; or whatever I'm using at cheap rates.

That drives the utility planner up the wall. The only way you're going to get around that is where the industrial plant that is a potential co-generator and the electric utilities system are growing at the same time so there can be some kind of mutual planning and where the off-peak power that can be provided or the day long power that can be provided can be factored into the overall utility planning system.

Even if you make that little deal, you then have one other problem, which is something that every industrial manager faces. That is the way the laws are presently construed as soon as you tie into the grid system, you're treated as a public utility. We have enough trouble making profits, much less going to the Public Utility Commission every year to have those rates set. There's a natural, and I think, legitimate hesitance of the industrial manager to become regulated by the Public Utility Commission, to the same extent that his utility is.

Now, there is one other problem that we face with that. People have suggested in the past, within the Department of Energy, we have tried to deal with co-generation and the regulatory barriers to it. One of the appraoches has been we'll de-regulate the price of electricity and the point of exchange so the utility and the industrial co-generator could make whatever arrangement was in their best interest; the two of them. The problem is there is no Public Utility Commission in the United States that will allow a utility to engage in an agreement with any single individual for cheap rates of power; either in acceptance or in passing out, without passing the benefits of the lower cost onto other consumer within their jurisdiction.

So, there is a basic regulatory barrier, as well as the economic barrier, and it is hard to tell whether the regulations make the cost prohibitive or the cost makes the regulations prohibitive, but there are both of those factors that prohibit it, at least in our current structure.

DR. TAKAYAMA: St. Paul, Minnesota initiated the first co-generation project. Do you know anything about it?

MR. CASTELLANI: I don't know all of the details of it.

DR. TAKAYAMA: What is the current status of the project?

MR. CASTELLANI: I'm not sure what the status of it is, now. There have been a number of them that have gone forward with district heating. There is one major one that has failed because the economics could never be made right. That was 750 megawatts.

DR. TAKAYAMA: DOE's Conservation and Solar Office supported that one. They had a conference concerning it last spring, so the project must be continuing.

MR. CASTELLANI: It's a problem that continues to be wrestled with. There are investment tax credits for so called co-generation, you know, it brings up the problem; the definition of co-generation in the Energy Tax Act is different than the definition of co-generation in the Public Utility Regulatory Policy Act which is different than co-generation in the Power Plant Industrial Fuel Use Act.

That reminds me of one other point that inhibits co-generation. Co-generation now is primarily an oil and gas based technology because you have to have the quick cycling and steam turbines and gas turbines to meet your compressor loads or your mechanical drive requirements.

We have a national policy that says you don't use oil and gas in new facilities. We have an exemption in the act, Fuel Use Act, which says you get an exemption, use oil and gas in co-generation should the benefits of co-generation be otherwise not available. However, we have a regulation implementing that section of the Fuel Use Act which says that you can get an exemption to co-generate in the event the economies of it are not otherwise available and you demonstrate that you're unable to use coal or another alternative fuel under the provisions of the acts of the government. Is making a conscious decision that it is more valuable to use coal inefficiently than it is to use coal efficiently? That is going to act as an inhibitor for co-generation.

DR. ALT: Thank you, John. Any more questions from the floor?

PARTICIPANT: First, a quick statement. I don't agree with everything you said on co-generation. I think that a lot of the problems are being addressed at different levels; that a lot of your statements about --

MR. CASTELLANI. I'm not condemning it. I'm just saying the great euphoria and its vast contribution is overstated.

PARTICIPANT: I have two questions. One's to Mr. Castellani. One; what are you going to switch to after incremental pricing, since the price of gas at number 6, high sulphur oil is two standard deviations to the left? What is going to be cheaper?

For Mr. Guerin, he may have just misspoke himself when he said that master metering depresses electric use. Was that the statement that you intended?

MR. GUERIN: No.

PARTICIPANT: Where people aren't billed directly for what they consumed, they use less.

MR. GUERIN: When people are billed directly for what they consumed, they are going to be using less than when they have a master meter.

In other words, you should be taking the master meters out.

PARTICIPANT: Okay.

MR. CASTELLANI: Does everybody understand what two standard deviations is below the --

(Laughter.)

DR. TAKAYAMA: 30 percent.

MR. CASTELLANI: Quick history; there is a ceiling on the incremental pricing of natural gas liability. That is the exposure that the incrementally priced user would see. The ceiling is the price of an alternative fuel, distillate fuel oil, and/or residual fuel oil determined on a region by region basis.

What is the right number; is it 39 regions?

PARTICIPANT: I think what they finally decided was that each state is a fuel region.

MR. CASTELLANI: There was a proposal originally for 39 regions. The implementation is the first rule. FERC has said that the exposure, the maximum ceiling, is the price of low sulfur residual or high sulfur resid.

This is only the first rule; a second rule coming which relates to non-boiler fuel uses and feed stock uses. Clearly, that will depress a lot of the impact of incremental pricing; except if FERC, in its infant stage implementation of the rule says that taking this concept of substitutability, then for process uses, it obviously has to be distillate fuel oil.

Then you have the situation where the more valuable uses of natural gas process and feed stock are subsidizing the, presumably, less valuable uses of boiler fuels. I don't even think Congress intended that.

Now, if you then look beyond what incremental pricing does to you; and it does raise the price of natural gas faster than the price of gases going up; once you reach the ceiling, you stop there. Then you all go up together. You don't wait for the residential sector to catch up to you. Combine that with the changes that we have in curtailment and combine it with the future outlook in that proposed rule.

The curtailment rule has said in the past that the most valuable uses are home and small commercial. We don't take any exception with that. Then they have said that the next most valuable use is process or feed stock and the least valuable use is boiler fuel use.

But there is a change in the 1978 act. It says, "The most valuable use is home heating and small commercial. The second is agricultural and food processing use, no matter what." Whether it's in a boiler or in process, then the third is industrial process and feed stock uses. The fourth is all boiler fuel uses that are non-food processing or agricultural. So in time of shortage, you would lose your process and feed stock used of natural gas before the agricultural industry and food processing industry users; the boiler fuel users. It's a little bit backward, but price is more than a determinant in those.

You have the influence of price. You have the influence of uncertainty in supply scarcity of supply; and in the past, because natural gas has been the cheapest fuel, the industry responds in conservation of natural gas; has been because of scarcity.

In the future, you'll have the additional increment of price in it, because of incremental pricing.

PARTICIPANT: Just looking at two standard deviations to the left -- step one, we're not going to lose many --

MR. CASTELLANI: You will, to a certain extent insomuch as the rate of rise in price of natural gas to the industrial user; the rate of increase will be greater than that of consuming segments taken as a whole. Your ability to switch is limited by the technical substitutability in another fuel; but that is also determined by how much money it costs to find that technical substitute.

PARTICIPANT: And then you go on to say, or seem to say that you think that the users of natural gas are going to view future curtailments as a partial possibility.

MR. CASTELLANI: In the past, it has been a possibility.

PARTICIPANT: The Shah of Iran is cutting off our oil supplies and you can't get your oil. I just can't see from whatever you're saying, that your're gong to see a massive switch to another fuel. All the other fuels are going to run and hide someplace else; get off the pipeline and jack up the prices to everybody else.

MR. CASTELLANI: If you recall, this is the EIA's projection where a substantial decrease in the price of gas results in increase in the industrial consumption of natural gas.

I suspect that it will be relatively level, although decreasing as natural gas supplies decrease. The relative impact of incremental pricing, as you describe it, is fine if you take the nation as whole and assume that it is evenly distributed. But, we found in trying to determine the cost impact in potential liability -- it is so depend on the makeup of the customers serving the distribution company and the interstate pipeline that we now have. A lot of companies are looking very quickly around to get off the natural gas piepline system because the projected impact of incremental pricing will put the cost of natural gas to them; the rate of increase in the cost of natural gas to them; above what they believe they can get other sources of energy for.

PARTICIPANT: And all I'm saying is what other sources?

MR. CATELLANI: What other sources? Well, as I talked about distillate fuel oil has been the primary one.

PARTICIPANT: You're going to get distillate fuel oil at less than two standard deviations to the left in number 6 fuel oil.

MR. CASTELLANI: Again, the two standard deviations is not the cost of natural gas or the industrial fuel oil. That is the extent of his liability as dissipating the surcharge.

PARTICIPANT: But he can't pay any more than that in total.

MR. CASTELLANI: Sure he can.

PARTICIPANT: How?

MR. CASTELLANI: Because as soon as the surcharge pool is dissipated by everybody in the pool, reaching the level that you're referring to, then both the industrial fuel user and the non-incremental price fuel user must dissipate all cost of gas. So, you have quickly brought the industrial fuel user up to that ceiling, then you go up like this above the residential consumer.

PARTICIPANT: Not if you have a responsible state regulatory commission.

MR. CASTELLANI: That's not true. You know that Congress has guaranteed the well-head price of natural gas will exceed the inflation rate by 4.7 and 3.7 percent per year.

So, it surely is going to go up if the price of distillate fuel level is off. It should be so good to go up only by 2 and a half or 3 percent per year, real dollar increase. Then, the price of natural gas will always exceed the price of distillate or residual fuel oil in rate of increase. So the ceiling, the cap is the only way to jack me up first to bear a bigger burden than the residential consumer; then guarantee that I'm above them, all the way.

PARTICIPANT: What you seem to be saying is that I will assume that you are a few years older than I am.

MR. CASTELLANI: I doubt it.

(Laughter.)

I'm a very mature 16.

PARTICIPANT: I'm a couple of years older than you are, all right. I'm aging annually at a slower rate than you are, so, I mean, if we extrapolate that, you're going to be older than I am, eventually.

(Laughter.)

MR. CASTELLANI: Unfortunately, the system of natural gas pricing under the Natural Gas Policy Act is not done chronologically. It is done quite deliberately to make sure that one segment of the consuming population is subsidizing another segment.

If you would like, I would be happy to share with you or give to you the exact case studies done in terms of the impact of that increase.

PARTICIPANT: I'll talk to you later on.

DR. ALT: Charles?

DR. MYLANDER: I think on this incremental pricing, there are two things that ought to be addressed. As we were conferring, we're not quite sure if we modelled the things correctly, but let's tell you how we modelled them. They do affect this discussion.

One is the projection in the annual report where we show industrial use of gas declining; this is a result of the assumption that the alternate fuel cap would be distillate fuel; not residual fuel oil.

When the policy people saw our forecast; they realized, as some of what Mr. Castellani realized, and advocated and worked hard to get the cap changed to the price of number 6 fuel oil premisethe two standard deviation thing around it to prevent this impact.

EIA ANALYST: I believe that the way -- the way that we modelled it was once -- the industrial user hits that cap, their price remains constant, stayed there and waited for the other sectors, to use up the incremental accounts.

I believe there was some confusion when the law was being written. There were several versions. One that said that the industrial users stayed above, and they sort of split the extra charges above that. But there were also some difference. One that came through was once you hit the cap -- you --

MR. CASTELLANI: We're not entirely convinced that that is the one that came through. That is the contention, but we're not convinced yet.

PARTICIPANT: You could suffer a one month set-back, I think under the present plan. Once the system gets up and running, you could share the burden of the first month; after that you would be limited to the ceiling.

I think that is the way it works out.

DR. ALT: Was there another question? Regarding the cooperation between EIA and the regional planning center, I might say that some differences could occur because of the regional planning centers not knowing something that you do; this is more likely to be the case.

Okay. It is still somewhat early for the break. I believe that the refreshments should be out there. So, perhaps we could reconvene at 3:25 instead of 3:30.

(Recess.)

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CHAPTER 11

IMPACTS

SPEAKERS:

Dr. David Sandoval, Energy Information Administration
Mr. William Curtis, Energy Information Administration
Mr. Edward Pechan, Energy Information Administration
Dr. Edward J. Bentz, Jr., National Alcohol Fuels Commission
Mr. Larry Moss, Energy Consultant
Mr. Edwin Rothschild, Energy Action Education Foundation

DR. ALT: Welcome to the final session of the symposium. For this session, we would like to address part 6 of the Annual Report to Congress, which is titled "Impact of Projected Energy Production and Consumption."

This is concerned with both economic impacts as well as environmental impacts. Our first speaker from the EIA sector is Dr. David Sandoval. He is a senior economist with EIA.

DR. SANDOVAL: I'd like to welcome the hard core conferees to this session. If you don't mind, could you flash on the first chart?

(Refer to Figure 11.1)

I'll start by providing a general overview of the impact analysis that was undertaken as part of the ARC-78. Actually, the one arrow, the one that is bent all out of shape, is also pointing in the wrong direction, I think.

(Laughter.)

Actually, the relationship is the other way. The arrow will be corrected for the record.

DR. TAKAYAMA: It's the right thing; it says projections.

DR. SANDOVAL: The causal effects go from the energy system to what is labeled the Comprehensive Human Resources Data System. There is no feedback effect yet.

Though, for the ARC-78 effort, there was a feedback effect established between the element in the chart labeled DRI Model of U.S. Economy and the energy system. Actually, there could be an arrow going from that element up to the Macroeconomic Assumptions elements and then back up to the Mid-term Energy Forecasting System element. In other words, there was an iterative process undertaken for ARC-78 that had not been undertaken before.

SCHEMATIC REPRESENTATION OF THE ENERGY/ECONOMIC/ ENVIRONMENTAL ASSESSMENT SYSTEM

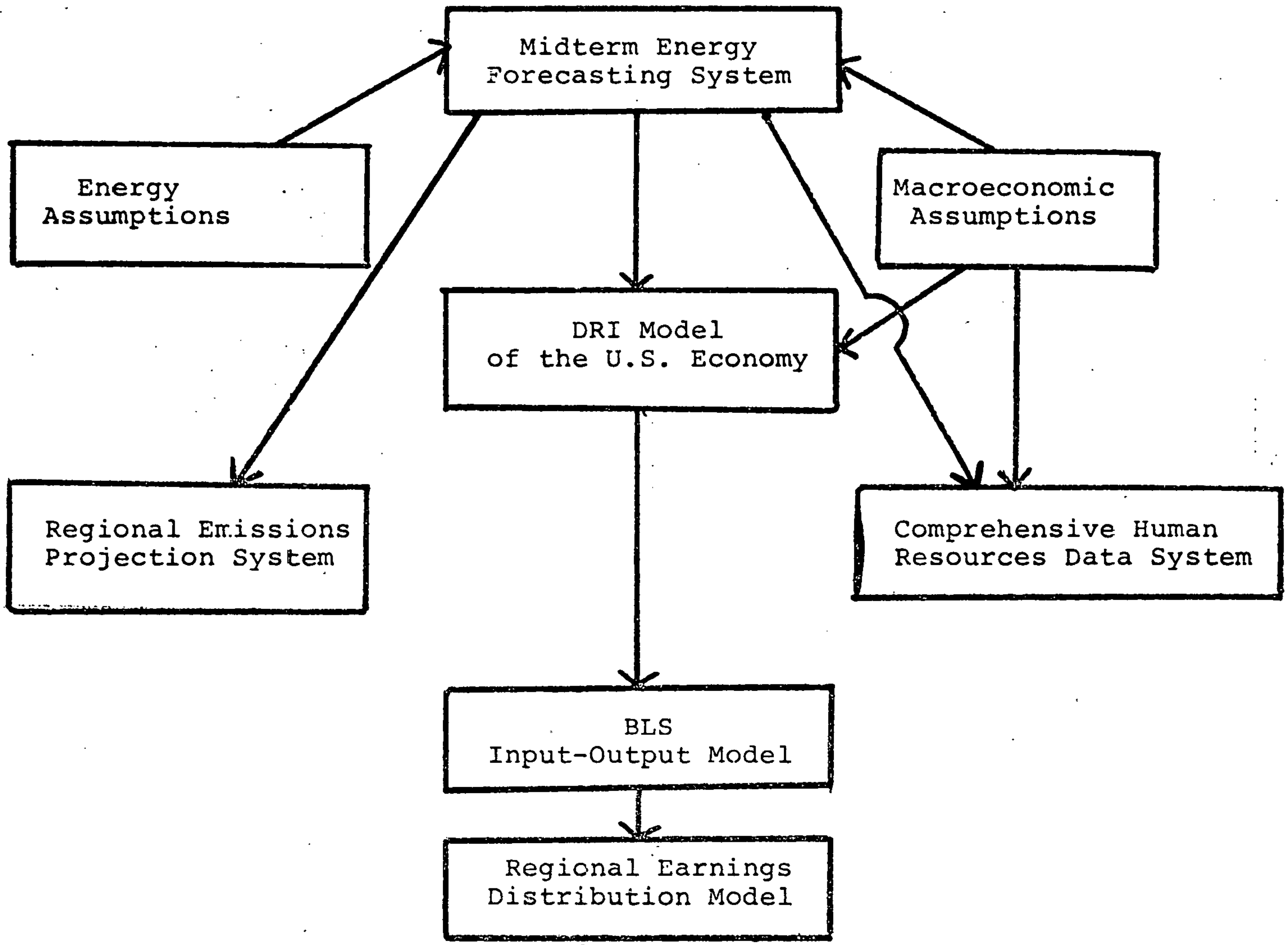

Figure 11.1

The DRI macro model represents the macroeconomic analysis that was undertaken for the ARC-78 effort. The element entitled Comprehensive Human Resources Data System represents the micro analysis effort undertaken. Over the years, this type of analysis has also been entitled distributional analysis and socio-economic impact analysis. So, that gives you some idea as to the type of analysis that is undertaken under this segment.

Obviously, the regional Emissions Projection System element in the chart represents our environmental analysis effort. Ed Pechan is here and will describe the work that was done in that particular area.

Two other areas of our impact analysis effort for ARC-78 are represented by the last two elements in the chart. First, there is the BLS Input/Output Model element. I believe that the EDIO version of the Bureau of Labor Statistics input/output model was used this year--that is, the Energy Disaggregated Input/Output Model. The analysis represented in this element of the chart concerns itself with industrial and employment impacts at the national level.

Finally, there is the Regional Earnings Distributional Model element which represents the regional economic impact analysis undertaken, primarily at the macro level.

I might mention that in terms of regional analysis, the area I was involved with last year, we have collaborated with the Bureau of Economic Analysis, using their National Regional Impact Evaluations System (NRIES), to try to establish a direct linkage between midterm energy forecasting and regional economic impact analysis. This work is under way. For example, BEA is currently using NRIES to evaluate the regional economic implications of the energy projections associated with ARC-78.

At this point, I would like to ask Bill Curtis, who works with the macro-economic models to give a brief discussion of their work and of the results derived for ARC-78.

MR. CURTIS: Thank you. Referring to this diagram, up here, the start of the iterative process that was used to get the macro-energy interaction was to take a DRI long-term trend forecast.

For example, for the series C case and the medium growth trend line, a DRI TRENDLOG forecast was used. Then, this was used to both directly drive the demand model of MEFS, and also to be fed through the REGSHARE model--which shares out certain economic variables to regional levels.

Then, these two separate model outputs were fed into the demand models. So you're starting with your trend forecast, going to the MEFS system. The variables fed were basically, the inflation rate, industrial production indices, disposable income--basic variables that appear in the demand model. Then the demand model, which is a dynamic model, has its output converted to the static demand curves for the LP system.

When you get your energy prices and a few other energy values out of the MEFS system, what was done in the last annual report, that was not done previously, was to then feed energy prices and certain other things into the DRI model to try to iterate to a better true convergence between the two models.

Now, when you do this, you do get a different solution than if you did not do this. I have been told that you tend to get an overreaction in the first round, in the macro model of about double what you finally end up with when you go through the second iteration.

So, it's fairly important to go through this stage. Unfortunately, the version of the DRI model that was used for this last annual report is not terribly energy-rich, so the number of variables you're feeding into the macro model is fairly few. Basically, there are five or six of them: the level of imported oil, the price of imported oil, and the overall wholesale price index for energy. Also, there is a consumption level for gasoline and a price of gasoline, or deflator for gasoline.

Those are the basic five variables that drive macro model in this process, and get you your sensitivity to the different energy variables.

The production index for the refining industry is also fed in, but that doesn't really drive the macro model the way it is constructed.

It is important to keep in mind in evaluating the way this works, I think, that it does have some serious limitations. You may be getting smaller impacts, possibly, than you should because of the fact that you're not dealing with a truly supply constrained macro model, and also because you're not dealing with an integrated model structure, here.

But, efforts are being made to improve this. Certainly, I think, when you look at the energy scenarios and see what variation you're getting in the macro variables, you can see that these impacts are fairly small; in scenarios A-E, the ultimate GNP inflator in 1995 varies by about 6 percent from the highest to the lowest.

Likewise for GNP itself. You get a 3 percent variation, I think, in the final 1995 GNP when you examine you high world price C scenario and the low world price C scenario. So, the macro impacts tend to be smaller than you might get with a better structure.

In the future, basically, I think what we're aiming at is getting a macro model which is richer in energy detail--which the new DRI model will be--and, ultimately, trying to build in to the MEFS system a model which is more supply-constrained.

I guess maybe I should take any questions.

DR. SANDOVAL: The questions will come later. Now, Ed Pechan will talk on the environmental model.

MR. PECHAN: Thank you. When I was first asked to make this presentation, I thought that there were a number of possible things that I could talk about. One would be to review the findings that we presented in the published study.

I thought that would probably not be useful to you, since you have that available to you. Another possibility was to go into some detail concerning our analysis approach, our methodology. I felt that would not be useful, because we have some documentation on that now, and it covers that aspect fairly well. We have some that is available and some that is being prepared.

So, I felt it would be better, perhaps, to step back from the specifics of the analysis and talk a little bit about some general things.

Could you put up the first slide?

(Refer to Figure 11.2)

I have divided what I wanted to talk about this afternoon into a few topics. The first, really, is to talk about the generic types of issues. What are the characteristics, just generally, of environmental issues that we face when we look forward to projecting what the future energy system in the country is going to be. That is a very general question. Then we get into what is EIA's interest, at all. Why should we look at this; what are our objectives; what do we want to find out?

SCOPE OF PRESENTATION

- ENERGY-ENVIRONMENTAL ISSUES
- EIA's OBJECTIVES
- EIA's ANALYSIS SCOPE
- EIA's ANALYSIS METHODOLOGY
- SELECTED NATIONAL FINDINGS

Figure 11.2

Then, again, to be a little more specific, what we have done; what we have been able to do to date, even though it's been very limited.

I do get into a little bit about methodology, just to indicate to you that it is fairly straightforward and we tried to use a fairly simple approach. Once again, I do not get into a lot of detail.

Finally, just to get into the nature of review, I want to mention a few of the selected findings from the national results; the ones that we felt were very robust over the range of energy futures that we were considering.

Would you put up the next slide?

(Refer to Figure 11.3)

We could look at the general nature of the issues involved, and, I think, what we need to do is put these concerns in the context of what we're trying to do in any analysis.

I think we found that we have a number of problems. I think that is what this really tells you. We find that, if we're looking at environmental issues, they tend to be very site-specific. A power plant may be affected significantly by some environmental regulation in county A. If it's moved a few miles, maybe to county B, it would not be as big a factor.

So, it's very difficult to generalize environmental problems because they are highly local in nature and we have different types of environmental standards. First, we have national standards; those we can assume will be met.

But then, we have a number of local issues. These local issures are becoming more and more significant. For example, in the area of air quality, we have prevention of significant deterioration. This is primarily an issue

ENERGY-ENVIRONMENTAL ISSUES

- LOCALIZED
- MULTIMEDIA
- MULTIPOLLUTANT
- CONFOUNDED WITH ECONOMICS

Figure 11.3

that affects certain areas; other areas it doesn't affect at all. The same can be said of non-attainment. In the next point, we're concerned with environmental problems that range from air pollution to water pollution and to solid waste issues.

Any of these issues can be important in a particular site. As I indicate later on, we focussed on one medium. I think it's very important to realize that there are lots of other ones out there; also that--and I don't include it specifically, here--these factors all are affected by the fact that the regulations are changing over time.

For example, the major focus on federal regulation of water pollutants has been on a very short list of what I call traditional pollutants: biochemical oxygen demand; suspended sediment. Now they're working on ambient standards for the 65 so-called priority pollutants that have been set as a result of legal action.

These pollutants are ones that are much more affected by energy development. We find that power plants, for example, put out very little biochemical oxygen demand. So they're not affected significantly by the standards that we have today; but, on the other hand, power plants put out a relatively significant amount of copper. That is one of the priority pollutants.

I've kind of run over in talking about this next point, which is that there are many pollutants involved. I mean, so many that it is very difficult to even count. In fact, it depends on how you count.

EPA is developing the standards, as I said, for 65 priority pollutants, but they have gone ahead and listed those same pollutants in a different way and come up with 129 pollutants that are actually the same.

So, we're getting involved in different chemical species. We're talking about trace metals, subcompounds of trace metals, and it becomes very, very difficult. It is very difficult to even characterize what the emissions are.

Finally, I think that the major point is how these things relate to economics. If you set a standard, it's going to have an economic effect. It will affect one technology more than another, perhaps.

So, as we look out to the future, we may find a different mix of technology selection due to environmental regulation, because to meet a regulation, one technology may be priced out of the market.

To give you another example, consider the prevention of significant deterioration issue. That limits the contribution to ambient air quality that any particular source may make in certain areas. So, one possibility is that it might require more stringent environmental control to meet this increment than you're able to achieve.

But on the other hand, maybe you can meet that by building a smaller plant which would have less emissions than the larger facility.

Once again, those are economic choices. A smaller plant may be inherently more expensive relative to its output, but a larger plant may have to meet a more stringent emission standard and, thus, require a larger investment in environmental controls.

Therefore, its economics may be adversely affected. It's confounded with technologies in another sense. Even if you assume that each technology can meet a given standard, at a competitive price, at some point in the future, if that standard is tightened, if that standard is changed, then one technology may not be able to meet that without a significant cost penalty compared to another.

You could, perhaps, look at electric generation; you might look at conventional technology with flue gas desulfurization and compare that with fluidized bed. For the present standards, you could almost say that they're fairly equivalent. But, if you had to tighten the sulfur dioxide regulations more, you might find that you're already very near the limit of what you can do with the conventional; much closer to the limit, let's say, than you would be with the fluidized bed where your sulfur dioxide removal is based on how much limestone you might add, or some process changes.

So, I just wanted to put these into context. There are some very complicated problems that are not easily dealt with. You should realize that we're trying to look at the larger perspective; and we can't examine every point in detail.

Could you put up the next slide?

(Refer to Figure 11.4)

I think our underlying objective, the major objective, that we have in EIA is to examine the range of U.S. energy features that are projected. We want to look at all of the cases that are being considered to see what difference it makes.

Does it make a difference? We can look at these ranges, both in terms of the specific MEFS scenario that we use as input as well as the year, as things go over time. Within that overall context, we want to look at the range of futures.

What do we want to find out? First, we want to identify most significant impacts, so that we can indicate what could be the potential problems that we see, given a particular scenario.

EIA OBJECTIVE

EXAMINE THE RANGE OF U. S. ENERGY FUTURES

- IDENTIFY MOST SIGNIFICANT IMPACTS
- QUANTIFY PROJECTED CHANGES
- PROVIDE QUALITATIVE INSIGHTS

Figure 11.4

Where possible, we want to quantify changes in the environmental conditions. This becomes very difficult, once again, since the nature of these things is primarily localized.

We're talking about being able to quantify these things at a much more highly aggregated level. That tends to limit the utility of it. In fact, I've said on a number of occasions that what we can best do, really in many cases, is to simply quantify the intuitive.

That may be a very useful thing to be able to do. Then, finally, I would say that we are able to, or we attempt to, provide some qualitative insights as well: just giving us an indication of regions and technologies and pollutants in which there may be some potential problems.

You know, these are things that I don't feel that we can quantify very confidently, that our results do give us some indication, some insights, particularly, if those results are fairly robust over the range of the futures that we are looking at.

Let me go to the next slide.

(Refer to Figure 11.5)

We do have a number of studies that have been published that present our approach in various ranges of detail. This afternoon, I just wanted to mention a few very minor points.

First, what pollutants do we look at? I said before that there may be a few hundred that would be of interest, ultimately. Right now, we look at five.

We look at five air pollutants, total suspended particulates, sulfur oxides, nitrogen oxides, hydrocarbons, and carbon monoxide. These are what I would call traditional air pollutants.

EIA's ANALYSIS

- FIVE AIR POLLUTANT EMISSIONS
- 313 SUBREGIONS
- EXCLUDES ECONOMIC/SITING ISSUES

Figure 11.5

They are more properly called criteria air pollutants because there have been ambient air quality criteria established for them. They are ones that we have a fairly good body of data on that we are reasonably comfortable with.

Energy facilities are also the source of other air pollutant emissions, for example, heavy metals--various specific organic compounds that, while they are included in a class of hydrocarbons, may be of great interest. They may potentially be carcinogenic. They may be a serious problem. We don't really have a way to accurately quantify that.

If you look at trace metals, for example, it is highly dependent upon the fuels. The exact assay of the fuel must be considered. Coal from one mine may be different than coal from another by an order of magnitude.

So, we're really not able to look at these very well. In terms of geographics, right now, we look at 313 subregions, but we never present the data at that level of detail. We don't feel that we're confident of it at that level, but we can use the quantitative results from that to gain some qualitative insights, as I indicated before.

I think one of the major things to point out, and it is a key limitation in our analysis, is that we do not include these extremely important economic and siting issues that I first mentioned a few minutes ago.

These are very, very complicated problems. For example, a particular environmental standard may adversely affect the economics of a technology. It may preclude its siting in a certain area.

We have done a few additional studies. For example, we looked at oil shale. This was a case where we felt that in even looking at traditional pollutants you were going to be very limited in the amount of oil shale that you could develop on the basis of the air quality increments.

That was an exception in that we were able to even quantify the effects at all. It turns out the reason is because oil shale is really only developable within a fairly limited region.

So these are some of the general characteristics. Why don't we go to the next slide.

(Refer to Figure 11.6)

I don't want to go into a lot of detail with this. This is actually taken from our documentation that we are in the process of preparing. In fact, I'm not sure why we're showing it at all, since it doesn't seem to fit.

(Laughter.)

Anybody interested in this should give me a call, and I'll send you the study when it's out. It should be out pretty soon. The key thing of interest here is that we have a direct link into the MEFS, so called, "cookie" data sets. We bring those in directly, so we can examine any of the MEFS cases.

Well, you can't really tell from this. The approach is such that we are able to computationally look at a particular MEFS scenario and get our so called standard output reports within a few minutes.

So, it is very fast turnaround. It is simple, although it is not really reflected in this how simple it is. It's inexpensive also. I don't want to spend a lot of time belaboring these things. Why don't we just go to the next slide, and I will just very quickly talk about what we did find. I would say that these findings were fairly robust over the range of cases that we looked at for the 1978 report.

(Refer to Figure 11.7)

REPS OVERVIEW

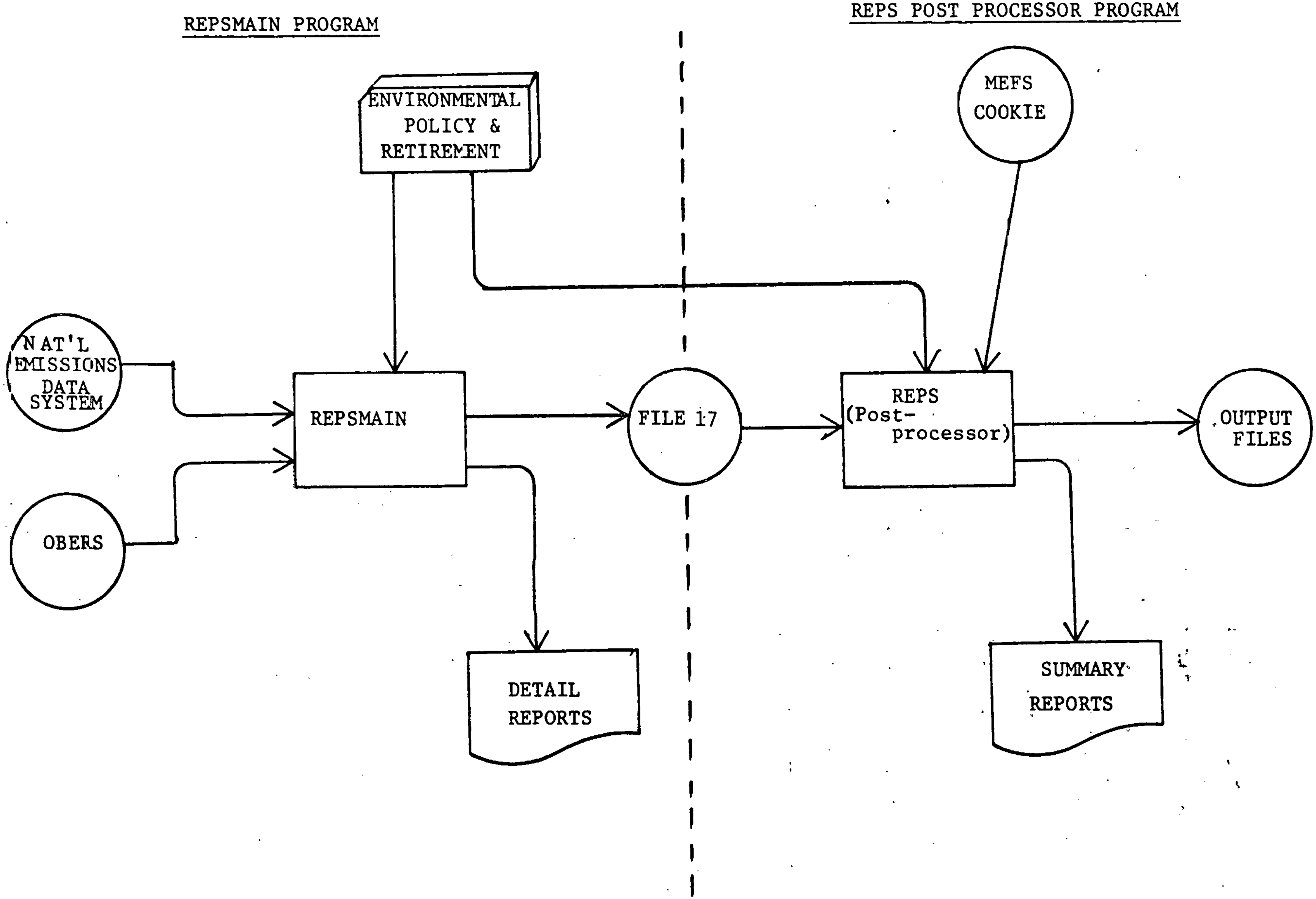

Figure 11.6

NATIONAL RESULTS

- TSP - SLIGHTLY HIGHER BY 1990
- SO_x - SLIGHTLY HIGHER BY 1990
- NO_x - SIGNIFICANTLY HIGHER BY 1985
- HC - NOT GREATLY CHANGED
- CO - SIGNIFICANTLY LOWER BY 1985

Figure 11.7

We found out that total suspended particulates and sulfur oxides, by around 1990, were showing somewhat slightly higher values than our base year which was 1975.

In 1985, they actually had gone down, but the changes were not really significant. I mean, one could argue whether they would really be increased. We did find a significant association here with NO_2, and we felt that was definitely increasing.

I don't think that is arguable. It was very robust. It was fairly high even in 1985; then it continued on up. This could be a major problem.

EPA, now, is reviewing the ambient air quality for nitrogen oxides. They may be issuing a short-term standard. This can be extremely significant to the utility industry.

This could involve, literally, billions of dollars in cost. There is no question that these emissions will increase. We don't really address the issue of how that affects ambient levels, but the magnitude of these increases is so large that one can assume that ambient levels would most probably increase also.

With regard to the hydrocarbons, we found that it was pretty much a wash. This was the one case where they showed a very slight decrease under some of the energy cases. They showed a slight increase under others.

But, the differences were so minor that we just feel that there was no significant change. Finally, I would just say that carbon dioxide is the big winner. It decreases by 1985.

Under any case, that is primarily due to tailpipe controls on automobiles which are still being implemented and still being reflected in the fleet.

I think that is basically all that I had.

As I said, there are a number of studies that we have that you are welcome to request and receive. Thank you.

DR. ALT: I thank the EIA speakers for their comments. Now, we would like to turn to the other side of the coin. I would like to introduce my next speaker, who received a Ph.D. in nuclear physics from Yale in 1971. Prior to joining government service, our speaker was a member of the technical staff of the RCA research laboratory.

Among other things, he was the first environmental director of Yale Law School's Yale Legislative Services. Our speaker more recently was Director for Impact Analysis at the National Transportation Policy Study Commission.

In this capacity, he directed all forecast, energy, environment and coal studies. Prior to this position, our speaker had been a senior policy analyst with the U. S. Environmental Protection Agency.

While working there, he also served as a special assistant to the Assistant Secretary of State in the development of U.S. foreign policy initiatives in the oceans and international environmental and scientific areas.

With that, I would like to introduce Dr. Edward J. Bentz, Jr., who is currently the Executive Director of the National Alcohol Fuel Commission.

DR. BENTZ: Thank you. I don't believe the stamina of the group here today.

(Laughter.)

Yes, I guess there are several other sides to the coin. The side that I would like to very briefly mention has to do with, perhaps, ommissions in the EIA report or, perhaps, different perspectives and emphases in which the report can be viewed.

Initially, I would like to compliment the people here: Dr. Sandoval, and others for the report. I think it shows a great deal of work and work that can be used.

There are two major points I would like to make. First is that I feel that in the future, there is going to have to be a bit more work on the alcohol fuel area. We all know our supplies of crude (domestically, including Alaska and off-shore) are small and rather limited and our foreign supplies are rather insecure, vulnerable and highly uncertain. The development of domestic resources, as well as conservation, and other synthetics (shale and coal liquids) are going to be essential. In the short run, i.e., to 1985, I think we're really talking about conservation and about alcohols.

The second point is a comment on an omission, if you call it such, of the needs for transportation infrastructure necessary to move that energy of tomorrow.

You can produce all the energy you want, but if you don't get it where you need it, your're not going to have it. This is particularly important because many of our domestic supplies are in areas not presently serviced by transportation infrastructure (be they pipeline or other forms; particularly coal movement, in terms of the railroad's capability of transporting them.)

With respect to the first concern, alcohol fuel, I prepared a little submission for all of you to read and for the record. It will be given out. This will help a bit. I thought many people here, possibly, would not know what the National Alcohol Fuel Commission is, what it does and how, perhaps, some of the work that it is doing or plans to do can mesh in and complement the work that EIA is doing to make that total effort stronger.

Very briefly, the commission, which is a joint Presidential/Congressional commission, was created about 3 and a half months ago. It is chaired by Senator Birch Bayh of Indiana, and vice-chaired by Robert Roe from New Jersey. It has six senators, six representatives and seven members appointed by the President. In its enabling legislation, it is directed to assess the short- and long-term potential for alcohol fuels derived from feed stocks that are biomass in nature as well as coal.

Biomass is specifically interpreted in the legislation to mean, not only the conventional grain materials that can be converted, but also some of our solid waste material. Solid waste, as Ed (Pechan) points out, has a nuisance value. We are also looking at marine material.

(Refer to Table 11.1).

With that objective in mind, the Commission, in its three months of existence, has several studies under way.

Let me just very briefly highlight them. One is a study of the net energy balance of alternate alcohol fuel production and to use technology. I.E., we are comparing different fuel cycles, both conventional fuel cycles as well as non-conventional fuel cycles. I emphasize the word fuel cycles to include end use production and distribution.

Another study is our Food (feed) vs. Fuel Study. This study attempts to marry some of the agricultural concerns in terms of productivity for different type crops, conventional and novel (including export sector) with those of the energy sector.

Next is our distribution requirement study for alcohol fuels. A fourth study is an assessment of the current short-term capacity for bringing alcohol fuels on line.

Table 11.1

REPORTS PRODUCED BY NTPSC IMPACT TEAM AS PART OF JOINT NTPSC-DOE AGREEMENT

Report No.	Report
SR #9	Trends in Transportation Technology (Bentz, Coar, Kahn, PMM)
SWP #14	Transportation and the Environment (Bentz, Conley)
SWP #15	Transportation Forecasts (Bentz, Schleiffer)
SWP #16	Transport and the Movement of Coal (Bentz, Beach, Gutman, Luxenburg, Levine, Nemschoff, McSweeney, Prokopy, and Williams)
SWP #17	Energy Use by Transport (Bentz, PMM)
SWP #29	General Social and Economic Forecasts Through the Year 2000 (Scenarios Documentation) (Bentz, Conley, Futures Group)
SWP #33	National and Regional Forecasts of Energy Supply, Demand and Price Through 2000 (particular focus on transportation fuels) (Bentz, Kahn, SRI)
SWP #34	Regulatory Factors Affecting the Supply and Demand for Transportation Fuels (Bentz, Schwamkrug)
SWP #35	Environmental, Health and Safety Assessment of Some Alternatives for Producing Liquid Fuels for Transportation (Bentz, Salmon)
SWP #36	Potential Refinery Bottlenecks Affecting the Supply of Transportation Fuels Through 2000
SWP #38	History of Supply and Price of Energy Fuels (Bentz, Schwamkrug)
SWP #39	Contributions to the Foundation of Supply for Energy and Transportation: Concepts, Economics and Technologies (Bentz, Sawyer)
SWP #40	General Description of the SRI, International National Energy Model (Bentz, Hirschfield)
Not Yet Assigned a Commission Number	Utilization Concerns (Bentz, Coar)

If push comes to shove, like we may have in the Iranian situation now, we would like to know just how much motor fuel and extender additive we can bring on line within 30 days to one year.

It is believe (as in World War II it was believed) that there is a lot more capacity there than meets the eye; and it is well worth looking into.

Another study area is what we call "on-farm small-scale" production of alcohol. The chief benefit here is the farms are highly dependent on energy not only for fertilizer, but for fuel in harvesting their crops; and, on-farm production of fuel makes the farmers more self-sufficient in energy. In the far case, the price of energy is the second consideration to the consideration of availability. If the farmers can become energy self-sufficient, it not only frees up allocation of fuel for other sectors, but enables the farm sector to produce as they had been producing which is the highest productivity of any sector in the U. S. economy over the last 10 years.

Similarly, we have studies in transportation and use, studying both conventional and novel technologies (in the transportation sector) to burn alcohol fuels. Indeed, one of our objectives is to assess the needs for catalyst equipped cars if we have higher blend alcohol fuel cars that burn cleanly. This would serve real consumer expense as well; there is a great opportunity there.

We are also looking at new alcohol production technologies, such as taking solid waste and converting it to alcohol (such as garbage and crop residues.) Also, we're looking very heavily in the methanol area -- methanol from coal as well as methanol from wood and wood residue stocks.

These studies will be finished in time for our final report which is due next July. We go out of existence promptly after that.

To date, we have had hearings to complement our work -- hearings in Indianapolis, Portland, Jonesboro (Arkansas), Secaucus (New Jersey), and a hearing tomorrow and Saturday in Salina, Kansas. One of the reasons hearings are so important is that a lot of the activities going on in this area are very current and fluid. Only by going out there can you tap it.

We brought along some copies of reports of our hearings. We believe, as we find things out, in reporting them to the public, so people can comment on them. They can share in the information as quickly as we can.

Similarly, a lot of our work is directed towards recommendation for legislation. Right now, there is much legislation on alcohol fuels. There are roughly 70 bills in the House and Senate on alcohol fuels either as part of a synthetic fuel bill package, or as part of a windfall profits tax bill, or as an agricultural bill. A key part of our work is keeping abreast of these developments and providing legislative recommendations.

As many of you know, the synthetic fuel bill is up for a vote in the next couple of days, S-932. What I've listed in the handout, is a quick snapshot of some of the key parts of 70 bills involved.

I also brought along a legislative compendium which we prepare every week, updating all the bills and their status. When my assistant gets a chance, he'll hand that out.

In conclusion, one of my purposes is to make these things available -- bring them to your attention, so they can be melded in to your on-going work. I was very happy, earlier in the week, to speak to several of the people in the EIA who were pleased to take this information so they could strengthen and complement their work.

I now look to another topic: the transportation capability to move fuels. I think this is a very serious problem. I believe something has to be done about it, because otherwise we might have an illusion of our capability to produce fuels and use fuels -- since we may not be able to move them.

In that regard, I'd like to bring to your attention some work which is very detailed on transportation requirements for present fuels, most importantly for projected fuels; and particularly for coal and for synthetics, that was most recently done by the Transportation Policy Commission. This work was put out in a report called "The National Transportation Policy Study Final Report."

Briefly, this study used a very large series of models. There is a set of 13 integrated transportation energy models that were put together over a period of about two years for the study. They are regional coupled energy and transportation models.

Transportation links were created from scratch by the Transportation Policy Study Commission staff. This is the work I formerly headed up. It is still winding up; the Commission is going out of existence on December 31 of this year.

The documented backup for this work is a series of 14 energy synthetic fuel transportation reports that sit as a basis for that information. There is, particularly, one report that looks at the transportation capability from now to 2000 to move those fuels, either in synthetic form or in raw unbeneficial form, such as coal.

In that report (here), there is a brief appendix. We had to shrink 5000 pages of reports down to 10 pages of Appendix. There's an actual picture, a map of the future, of the actual rail lines in the United States, west and east -- physical rail lines and links that will have to be able to move coal. Not hypothetical networks, but real links; the projected tonnage of coal; projected non-coal ambient tonnage; and what we feel they can and cannot move unless something is done between now to 2000 to significantly upgrade them.

DR. TAKAYAMA: You focussed on the output side or raw material into the plant?

DR. BENTZ: Both. For transportation, as you know, is a derived demand. It has to service the other demands, so you have to get the supply and demand picture and then create the infrastructure to meet that. Then assess the physical capacity and then assess the economic capacity to remedy the physical capacity including, of course, the impact of regulatory rules which in the case of the railroads are very strong.

Here are slides showing those fuel movements as well as slides showing the change in the refinery system. Our refinery system, right now, is suffering from very severe regional bottlenecks, considering the composition of the synthetics that we're talking about and considering the regional location. That is going to mean a lot of new pipeline hook ups and a lot of new pipelines.

They're not being built now; they have to be. Similarly, the environmental and other problems are very real, as Ed (Pechan) mentioned. We performed a separate study comparing the occupational and environmental health hazards associated with unit plans for 8 different synthetic fuel processes as compared with conventional fuels. This is one of the 14 reports I mentioned earlier.

Every time I look at these projections and look at the capital expenditures required, it makes alcohol fuels more and more attractive. Well, with that in mind, let me just wind up and say it's a pleasure being here. Thank you.

DR. ALT: Thank you, Dr. Bentz.

Our next speaker also has a nuclear background having received a masters degree in nuclear engineering from MIT.

Our speaker was a former national President of the Sierra Club and also served as Chairman of the Environmental Advisory Committee of the Federal Energy Administration.

He is currently a consultant on energy environmental policy. He is Chairman of the Environmental Caucus of the National Coal Policy project, an effort which brings together leaders of the environmental movement and industry to discuss and make recommendations on how to resolve key policy issues.

With that, I introduce Mr. Larry Moss, who is also the co-recipient of the 1979 Distinguished Service Award of the National Energy Resources Organization. Larry.

MR. MOSS: Thank you, Frank. I'd like to start off with two caveats. First, what I will say today represents my individual views and not those of any of the organizations mentioned. Secondly, my remarks are not a product of a complete review and evaluation of this annual report, because I haven't had the time to do that.

My views are rather a set of initial impressions obtained after reading parts of it, especially Chapter 24. This is the section on environmental impacts, the only section that deals specifically with that.

I find that, though the report contains useful information on impacts, it falls short with respect to several impacts of considerable concern. It is also not informative with respect to projecting the different impacts of alternative proposed policies.

EIA was created, I assume, to provide a neutral objective source of data for policy makers. Data they could rely on to evaluate alternative policies. And, at least in this chapter 24, I don't see the information presented in that way so we can assess what different environmental impacts might arise from different policies.

Well, let me make about five or six points, concentrating on those things that I think should be added to future volumes in order to broaden the scope of the environmental impact analysis.

First, I think it would be useful to note the present and estimated future progress in meeting the national ambient air quality standards, both primary and secondary, and the implications of that projection with respect to current statutes and regulations.

Admittedly, this will be a difficult thing to do. You may have to start off with a qualitative discussion of it based upon some of the quantitative analyses such as the observation we heard before about the very significant increase in nitrogen oxides, if things continue as they are believing they will.

But, eventually, I think we can get to be somewhat more quantitative, even in this ambient air quality analysis. It would be useful in connection with this to estimate the number of people exposed to concentrations above the ambient standards, now and in future years.

A second area where I think a significant addition can be made is in the regional and/or national air pollution impacts of certain of the important pollutants, including many of which are not currently regulated by law.

These include the sulfates and nitrates acid precipitation, all generally spoken of as secondary pollutants.which are not normally directly emitted from power plant stacks or other points of emissions, but formed from primary emissions in a process involving atmospheric emission.

We are becoming, I think, increasingly and justifiably concerned about these pollutants. Eventually in this country, we may decide to regulate them directly. To date, that has not been done. The regulation is only indirect, through whatever controls on total, national, or regional loadings are provided by such laws and regulations as prevention of significant deterioration of air quality and best available control technology.

In terms of ecological impact, for example, roughly 200 lakes in the Adirondacks are sterile for fish life because of acid precipitation. The possible health impacts of acid sulfates and nitrates in the respirable particle size range all point to the fact that we need to know more about what is likely to happen.

I suggest this as an area for careful examination by EIA. Before I leave these points, I notice, in the information that was project in chapter 24, that a projected large increase in total suspended particulates in the western states is believed to be in the cards.

When something like that is identified in the analysis, I think it would be useful to qualitatively, or perhaps quantitatively, describe what the likely impacts would be.

In that case, the impact might be quite large because, to take an example, many people value the clean air. Visibility is inversely proportional to particulate loading, roughly speaking. And, if you start from a very low base of particulate pollution, very clean air and add just a little bit to that, you can produce a very substantial degradation in visibility; whereas, you wouldn't notice the visibility if you added this to an area that was already at a high particulate level.

Those are the kind of evaluations that I think should be included. To do this kind of thing, I suggest use of models such as that developed at Brookhaven National Laboratories as a starting point.

It is also important to present the data in a useful form. Brookhaven, in fact, has developed forms of data presentation such as three dimensional pictorial models showing changes in expected ambient sulfate levels. That would make a very important addition to an analysis such as the one I have suggested and lead to an expanded environmental impact section in this report.

Now consider a third point where I think we can expand the analysis. Water consumption is a very difficult issue. It is politically highly charged especially in arid regions of the country. We need to understand, better than we do, the implications of projections on energy supply, such as in this report.

For competing uses of water -- both commercial and noncommercial uses, both those that involve withdrawal and those uses which are in stream -- possibly the need that is implied by information such as already in this report is for interfacing water diversion systems.

Perhaps, there is also needed a measure of some sort of the impact of some of these projections on the possible disruption of aquifers in arid regions where people depend upon aquifers for their commercial, municipal and industrial water.

A fourth area where information can be included is that of solid waste generation. This becomes especially important with regard to some of the syn fuels development, which are being talked about now. Oil shale, as an example, is the most dilute form of energy ever seriously talked about for commercial exploitation.

You get about 30 gallons of product out of a ton of shale -- from a good shale deposit. That implies an enormous amount of solid waste that has to be disposed of. This has implications for, perhaps, an impact on water quality in the region, and the leeching out of hazardous materials if that, indeed, turns out to be a problem.

Also, there is a large aesthetic impact from just putting that amount of material anyplace, filling up canyons. Again, I'm sure you don't want to get too site-specific in a report like this, but the gross figures, themselves, can give an insight into the scale of the problem and alert policy makers to the fact that this is something that requires careful attention.

Now, one more thing that I want to mention is carbon dioxide. Although it is not generally classified as a pollutant, people are becoming increasingly concerned about the possible climatic change impacts of changes in carbon dioxide concentration and what that might mean for the agricultural productivity of the world and the level of the oceans.

Again, I don't think it is the place of EIA to give the definitive word on that, but if the evaluations and projections of EIA point to a significant increase in carbon dioxide concentrations, that ought to be included. A flag ought to be on it that this is something that requires continuing attention; so that if it turns out that those potential climatic changes and other effects are likely to happen -- or at least there is a fairly high probability that they might happen -- then appropriate responses can be developed by the policy makers.

Now, I think it would be useful to project and estimate everthing that

I have spoken about so far, and other environmental impacts for a number of policy alternatives. You've got scenarios in this annual report that are focused on the price and supply of energy in its various forms.

There ought to be, maybe, three just to pick a number. Three is a good number; three scenarios that give altnernative approaches to controlling environmental impacts.

For example, one of those scenarios could be a simple extrapolation of present requirements already existing in laws and regulations. A second scenario might be implementation of what I would call a typical industry view toward these environmental impacts.

Such is the fact that many industry people would say we don't need best available control technology. It is not justified economically. We shouldn't worry about preventing significant deterioration of air quality in the regions as long as we meet the air quality standards.

Scenarios like that can be considered in the evaluation. Then a third scenario would be the implementation of what might be called the low impact technology alternative.

For example, if you're using coal instead of conventional coal combustion, even with scrubbers it might shift from that to producing a low Btu gas from coal and then removing the pollutants, the sulfur and nitrogen, when it is very easy to do it when they are in the reduced form (ammonia and hydrogen sulfide).

You can lower it to parts per mission, not to one part in ten. Then recover some of the energy loss you've experienced through combined cycle, possible co-generation.

I'm sorry I wasn't in on that co-generation discussion earlier.

Just to take another example of a low impact scenario, it might include more use of alcohol base fuels or hydrogen, if hydrogen can be made more cleanly than some of the ways that we do it now.

Then in the report, the projections can be made, not only for these economic and energy supply variables, but also for the choice of emphasis or de-emphasis on environmental impact concerns.

People are doing this sort of thing, at least, within certain defined areas. The current issue of Science Magazine has a paper by Sam Morris and a number of his co-workers on the likely environmental impacts of alternative energy supply technologies.

That kind of thing can be used along with other work in doing the analyses that I suggest and would be useful for policy determinations.

Let us go on to another kind of evaluation that might be in an ideal report. The report might also compare relative impacts and the cost of achieving them for different regulatory and economic schemes.

Up until now, I've talked about technological alternatives, but there are regulatory alternatives as well. Perhaps, the most clear distinction between two different approaches for achieving similar, even identical, goals of environmental quality would be, on the one hand, a scheme that relies almost entirely upon mandatory laws and regulations saying that X is illegal, but Y is permissible -- or .65X is illegal, but .66X is legal.

That is the one hand. On the other hand, a system of economic incentives or dis-incentives, as is typified by emissions and affluent charges, in which the charges are set at a level high enough to achieve the same goal, but the decisions are made not by hundreds of thousands of government regulators, each of whom has to know as much about the technology and the economics to make as an intelligent decision as the actual owner and operator of each facility; but instead, by the owners and operators themselves and under the pressure of the economic incentives or dis-incentives as they seek to minimize their cost and stay competitive.

This is easier said than done, but work on this has been done in a number of areas. For example, a report five or six years ago on sulfur oxide emissions contrasted the two approaches.

This one done by the now defunct Washington Research Center of the EPA, I don't know if that is the reason they are now defunct.

(Laughter.)

When we talk about large impacts and large costs and we want to better inform policy makers, I think we may have to look at things like this; look at different institutional arrangements, as well as just different technologies.

Well, there are obviously problems in doing what I suggest; but these problems are no greater, I think, than the difficulties of projecting supply of and demand for energy under sharply changing circumstances. EIA does not shrink from that duty.

In summary, I would urge that in future reports there be a broader scope in describing and projecting impacts on these analyses; and that is be focused on prospective alternative policies and developments.

I hope that the reason this was not done in the 1978 report is not that there is a lack of interest within EIA on providng a sound data base for the environmental impact dimension of energy policy. It is a much needed component, I believe, of their work.

DR. ALT: Thank you.

PARTICIPANT: May I just interject! The people involved in the Washington Research Center of EPA are now in the DOE Environment Group. It is not defunct.

MR. MOSS: Good. I'm glad they survived.

DR. TAKAYAMA: Glad to hear that.

MR. MOSS: I'll tell Larry that when I see him.

DR. ALT: I would like to introduce our final speaker from the non-EIA sector. I apologize for the short introduction, but unfortunately we didn't have ample time to obtain additional information.

I would like to introduce the director for the Energy Action Education Foundation, who is Mr. Edward Rothschild.

MR. ROTHSCHILD: I also have not read the entire report. I do want to focus on Chapter 23, ~~household expenditures projection~~, because I've had some experience with that and I think I can make some relevant comments that might be useful.

I only wish my wife was here, because she is in the Ph.D. graduate program in statistical evaluation. We continually have this disagreement between us because I come out of a social science background and she comes out of a mathematics background. The two of us, as far as I'm concerned, have a great deal of conflict.

I think that conflict was expressed when I tried to gain some understanding of the household energy expenditures projections chapter.

I think, probably -- I haven't read them all, and I won't say the weakest, but it appears to be an enormously weak section -- that the data base is probably highly uncertain. The kinds of estimates that are generated probably don't reflect what is going on in the real world.

I think a great deal of effort has to be made in gathering data to begin to make a model that, somehow, approximates the real world.

I have a great deal of trouble with a lot of models, having seen a comparison of some, with respect to world oil production where the differences between the lowest and the highest was approximately 18 million barrels a day. I think this is one of the great problem areas in modelling and in looking at the assumptions that go into the models.

The chapter on household energy expenditures and their projections does, at least, relate and state clearly the deficiencies that underlie the results; namely, the limited number of surveys that have been conducted. They were conducted in the early 70's. Thus, it is based upon the 1970 census, no long-term historical data, and only selected aspects of energy consumption.

I see that this chapter is very, very important because, when energy policy makers want to find out what the impacts are on families, this information becomes relevant.

When a statement is made, "...household energy expenditures in home fuels are projected to increase by $168 from 1975 to 1985...," I'm sure all of you in the room are going to take a gun to your head and say, "My God, who came up with that projection?"

So, I don't think that is very realistic, given what has happened to the price of energy today. That's another underlying problem. There is no real predictive or basic mechanism to project world oil prices.

No one projected $35, $40 oil. Today, the price of $31 a barrel for uncontrolled domestic oil was not projected or known last year. Those kinds of short-term sudden changes have an enormous impact on these household energy expenditures. There is no indication if you look at the chart.

As Deputy Secretary O'Leary said, "The people are having to choose between food and fuel." You cannot get that kind of estimate when you take the lowest income class and see $562 for all fuels, which is, roughly, a little more than 10 percent of the income class under $4999.

I am not enough of a statistician to tell you all the right things to do, but I think there are enough people around that can begin to think seriously about how to better analyze and project these kinds of figures.

We did an analysis. It was very, very rough to try to get some kind of increase per family for the decontrol of crude oil in the United States. Now, suppose you accept the President's or even the Senate Finance Committee's estimate of an increase of around $800 billion dollars in an 11 year period and you take the number of households in the United States and just divide that out because obviously those costs are going to be passed through either directly in the cost or fuel or in the costs of food and other consumption items.

You come up with totally different figures for gasoline or heating oil prices than the ones that you derived using your model. One can't really tell which one since the fuel is really not broken out. It says, oil, fuel, distillate fuel oils. You don't know on the distillate, for example, if that means number 2 or kerosene. Kerosene is used in different regions, and you don't know where those regions are.

The other thing that bothers me when I read some of these projections -- and I think it is efficient from the modelling standpoint -- is the use of constant dollar figures, 1978 dollars. For people who want to gain some kind of understanding of what it means in real terms, people's real incomes, you have to take whatever the index is and multiply it out to gain an understanding of what that $168 would be in 1985 rather than in

1978 dollars. So, I think one of the criticisms that I've always had is to try to do it both ways in constant and current collars so people have some real idea of what they are likely to be really paying in additional costs of fuel.

Finally, I want to go back to the other chapter that precedes this. There is, I think a basic lack of the overall impacts of higher energy prices on the economy. The models that are used really do not give any understanding for people I deal with.

When I go around the country speaking, I say, "Well, EIA says that it's going to increase, so and so over a period of time." People come up to me and say, "Well, that's impossible; I just paid $400 or $500 more in heating oil cost this year."

There is no link between what this report is trying to do, and what we find happening. My only recommendation, since I cannot give you specifics as to how to go about making the changes that are necessary in these kinds of reports, is to start over again without even using this report.

Start over to gather the basic data. I think EIA has the capability. EIA has to do that. It has to begin to use that data to be able to go back to the respondents as it has in the other areas with petroleum producers, refiners and marketers.

I think that is going to be very, very important in the future, since the energy pricing has become such an important expenditure of families and households.

I thank you. I'm sorry that I was not as prepared as I should have been, but we just had a change in our organization. I became director after serving as research director before. I was testifying all this week in a number of different areas, and I just thought I'd give a basic overview of that particular section of the report. I hope that it was useful. Again, thank you.

DR. ALT: Thank you, Ed. Dave, would anyone from your staff like to respond, briefly?

MR. PECHAN: I generally agree with most of what was said. I feel that these are major issues. I can't argue with that -- there is need for more analysis; you know that a number of these things have been looked at in other studies. It would be nice to incorporate a number of these analyses in the future.

You know, I can't disagree with that. Thank you.

DR. SANDOVAL: Jerry, do you have any comments you'd like to make? This is Jerry Peabody, who works with us.

MR. PEABODY: I was involved in the work for Chapter 23 on energy expenditures by household and would like to respond to the comments on that chapter. Mr. Rothschild had questions about the methodology used, and he found the results to be unreasonable.

The reasonableness of the results must be judged in light of the fact repeatedly emphasized at this workshop that the estimates of fuel prices made a year ago have turned out to be too low due to the unanticipated rapid escalation in the world oil price. Had currently prevailing fuel prices been incorporated into the analysis, household energy expenditures would constitute a higher proportion of income than is the case in the published analysis and would presumably be more "reasonable."

The household expenditure estimates are made with a computer model which contains a large sample of households that are representative of the United States population. For each household, we know the demographic characteristics and income of the family residing in the house. The thermal characteristics of the housing unit and the number and types of appliances in the household are also known, along with the types of fuels used for space heating, water heating and cooking. For forecasts into future years, these characteristics of the households are updated.

The quantity of each fuel used by each household is determined as a function of the household characteristics and the number and types of appliances that use each fuel. Total fuel use for all households or for particular groups of households, such as low-income households, is determined by summing the quantity of fuel used by each household in the category that uses the particular fuel.

This type of modeling requires a considerable amount of data, and the usefulness of this type of approach is conditioned, as Mr. Rothschild suggests, by the quantity and quality of available data. The most recent survey of household energy use that was available at the time of the preparation of the 1978 Report was conducted in 1975. The Energy Information Administration has recently completed a new household energy-use survey which provides a valuable new source of data. Data from this survey, and the surveys that are planned for the future, will enhance the quality and reliability of estimates of household energy expenditures.

DR. ALT: Thank you, Jerry. Larry would like to make a few comments.

MR. MOSS: I would just like to ask a question of the EIA people. To what extent are the numbers for future energy prices constrained by current administration policy?

For example, if it's the administration's policy to negotiate with the OPEC countries to keep the rate of increase in world oil prices from exceeding, say, 10 percent per year, would EIA, as an official government agency, feel constrained about making an assumption in its report that the prices might increase at 20 or 30 percent per year? Because if the OPEC people saw that, then they might say that you are expecting us to do this, and therefore, we might just as well do it.

The same thing with syn fuels. President Carter has said that we need so many million barrels a day of syn fuel production by some future year. Most energy policy people I know, even those who favor syn fuel's development, say that those targets are unrealistic and unadvisable.

To what extent does EIA feel that it has to use the official administration's positions in making assumptions about the future?

DR. ALT: Dr. Mylander?

DR. MYLANDER: Okay. You raised two related points in what you said just a minute ago and what you said earlier in your prepared remarks. EIA does not feel constrained by the administration's position. We have complete freedom to pick and to analyze what we think are going to be the world oil prices and to use what we want in our projections.

As a matter of fact, since about last June, the policy and evaluation people have been encouraging us to explore more forecasts with a wider range of prices than we had explored earlier.

So, they have encouraged us to go the direction in which we moved. For the first time, last year, EIA began making forecasts about what we thought, at that point, was going to be a reasonable range of uncertainty in world oil prices.

We'll try again this year to do forecasts under what we consider to be a reasonable range of uncertainty on world oil prices. We're trying to establish that range right now, without any interference or inputs from the administration or the policy arm of DOE.

On the syn fuel programs, you will notice that our analysis is not consistent with the President's program, as stated either in April or in July. We are under no constraint to justify his syn fuels program.

We are under no pressure to do so, either. In your earlier remarks, you asked us to explore more policy options. In that, we are constrained not to do this by the way EIA interprets its mandate under the DOE Organization Act.

We are not allowed to independently propose and explore such scenarios. Our annual report has to be policy free. It cannot explore policy issues.

It can, then, serve as a base case for exploring policy issues at the request of Congress or at the request of the administration.

So, our interpretation is we are legally required not to do what you ask in these environmental, policy issues. There is an Assistant Secretary of Environment who is mandated to do that kind of work.

Earlier, we had an analyst from the Office of Environment sitting in on this meeting. I hoped he could have spoken to that issue, but he has since left. They put a lot of money into and a lot of effort into exploring those kind of scenarios and have published an environmental discussion of National Energy Plan II that was put forth in April.

Then, another issue, I took both Mr. Rothschild's comments and your comments to be critical of our efforts. I felt that you misinterpreted some of our analysis by not having time to read the whole report. This observation raises the question as to whether our annual report should contain such chapters at all, because maybe this kind of material is better presented in completely unified reports that deal with these issues.

Then, even a more difficult question that we have to decide on for next year is whether we should include such impact chapters in the annual report study.

Then, on the environmental question, I think Ed was very modest in not stating the constraints under which we operated. He worked only part-time on this effort.

We spent less than $100,000 on contract support and consulting support to augment Ed's efforts. We feel that in the face of the kind of comment that Mr. Moss made that what we should perhaps do is not continue this effort; that we should take those funds and resources and put them into dealing with the problems that have been identified in the past two days in doing our energy forecast, and leave the environmental area to the Assistant Secretary for Environment who has a very large budget to do this kind of analysis.

MR. MOSS: I would like to respond. First, it appears to me to be a bit inconsistent that EIA considers itself constrained against doing any analyses which carry policy implications in the environmental area when, clearly, they are doing analyses that carry policy implications in the economic and energy supply area.

Questions, for example, such as whether demand and supply for energy is high, medium, or low are considered. Those carry a lot of baggage with them as to what makes them high, medium, or low and what policies went into that finding or that determination.

So, I'm not convinced, at all, that we have a qualitatively different analysis in the economic area than we have in the environmental area.

Your comment about the small resources put into this chapter, 24 -- which I found had some good information in it, and information which was useful to me -- just makes me conclude that you had a high ratio of benefit to cost in Chapter 24. I would hope that you would continue and expand it rather than cut it out.

I don't know how much money you spent on some of the other chapters; but, if your ratio of benefit to cost on the other chapters was as high as this, then that was money well spent.

DR. MYLANDER: Let me rephrase the question. If we are unable to expand the work, do you think the work at the current level should be continued? Is it valuable?

MR. MOSS: I don't want to give up so easily on the issue of expanding it. There was a reason, after all, that the kind of economic analysis that you have in here, energy supply and demand, was not just left to the regular part of DOE.

To me, that reason is valid for the environmental impact analysis as well. So, your response that since there are a lot of people in the rest of DOE doing environmental impact analysis, you don't have to worry about it, is not entirely satisfying to me.

DR. MYLANDER: It isn't to me either. I think some of that budget should go to EIA and we should get the money to do it right. We can't now do it in a way that I consider right.

(Laughter.)

MR. MOSS: I'm not suggesting you reinvent the wheel. You can review it; you can build upon it; you can decide what you like and don't like. Maybe your marginal expenditure can be fairly modest, although more than you put into it so far.

You can also draw upon other work sponsored by the rest of DOE and other agencies as well as what is going on in the private sector and in

National Laboratories.

DR. ALT: Ed, we have time for one brief comment.

MR. ROTHSCHILD: This will be very brief. I left one thing out and I think it is very important. That goes to the assumptions used in certain modelling, particularly with respect to world domestic oil supply prices.

As far as I know, and I don't think this has changed, the models used assume a competitive marketplace. Now, maybe one of the reasons that you are unable to have some kind of validity in charting increases in price is because you assume a free competitive marketplace.

In fact, there is a cartel of OPEC producers and, at least, many of us assume and believe that the domestic petroleum producing industry is not competitive.

I think it might be useful to include in any analysis the assumption that there is a free competitive marketplace and that the competitive marketplace is constrained by a monopoly structure. Under these conditions, see what happens to the results in terms of the price; and perhaps, give that as a range saying, "Well, some people believe it is competitive and some people don't."

Even though no one has come down and proven one way or the other. Court cases go both ways. I think it might be useful to see the extent and the sensitivity of the model of that kind of economic analysis.

DR. ALT: Larry would like to make one comment.

MR. MOSS: I would like you to use the money you might spend on that for Chapter 24.

(Laughter.)

DR. TAKAYAMA: It's a very quick trade-off.

MR. MOSS: It is a serious question. I hold a contrary view that, at least within the U. S., OPEC is clearly not an association of independent competitive enterprises. They do engage in collusion and price setting, but the price they come up with is a resource price that we, in the United States, have to pay for world oil.

Then, what happens in the United States in our domestic energy supply market in response to that price, I think, is exhibiting all the characteristics of a competitive market.

For example, if you believe that we don't have competitive markets, as people were persuaded a year or two ago, we're saying that if oil prices went up, coal prices should go up in parallel since the oil companies were buying out coal companies. They were going to be able to control coal production. It was in their interest to have the two move up in lock-step. Exactly the opposite has happened: as oil prices have gone up through the roof, coal prices have declined because of the surplus production capacity.

Everything you would expect to happen in competitive markets is happening. I expect uranium prices in inflation free terms will decline over the next five or six years for similar reasons.

DR. ALT: Julie wishes to be recognized.

MS. JULIE ZALKIND: I want to clarify one more thing. I think Mr. Moss had a misunderstanding on what we do in terms of what is policy analysis.

For instance, in our annual report, we wouldn't probably do a sensitivity analysis on alternative legislation sitting before the Congress on different forms of oil control or decontrol, but that is not a state of the world issue such as geology is.

When we did last year's scenarios A through E, we range the state of the world, not the state of future policies.

DR. ALT: We thank you. I would like to make a few final statements.

First, in preparing the initial list of attendees at this symposium, some of the speakers were omitted, not because they wished to remain anonymous, but because there was an oversight on our part. I point out that all participants will receive a completed list in the mail very shortly. It would be helpful upon leaving, to see if your name is on the initial list. If it is not, please give us that information prior to leaving.

Secondly, several participants have inquired about obtaining a copy of the proceedings of this symposium. Under the grant or contract that we have with EIA, our responsibility is to deliver the transcript in edited form to EIA by mid-February.

The publication and dissemination of the proceedings is, then, at the discretion of EIA. I imagine it would take at least two months to produce after we turn it over to them.

If anything has come out of this symposium, perhaps, it is that there should be amplification of a report that has been criticized during the symposium as being already unweildy. So how you handle that, I don't know.

I would like to express my thanks to the speakers and the audience for the comments that were expressed during the symposium, which we might call a town hall metting of the annual report.

Whenever I am tempted to go on and say several things, I always think of the story where the bull and tiger met in the jungle. A ferocious fight ensued. Eventually, the tiger won. After chewing upon the bull for a while he was so happy at being victorious that he let out a roar of approval. A hunter heard this on a hilltop and shot the tiger dead. The moral of that story is: when your mouth is full of bull, keep it shut.

With that, I would like to conclude the symposium.

(Laughter.)

(Whereupon, at 5:07 p.m., the meeting was adjourned.)

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SUMMARY AND CONCLUSIONS

The summary is designed to aid the reader in using the Proceedings of the Sumposium to Review Volume III of the 1978 Annual Report to Congress. The summary highlights the main points discussed by each speaker for each session of the symposium so the reader can quickly identify subject matter of interest and then turn to the more in-depth discussion in the actual transcript. The main points highlighted for each session are those relating closely to the topic of each session. Following the summary, the concluding section relates general comments and suggestions made by the Symposium discussants regarding the methodologies, assumptions, and results of the Energy Information Administration's work and Annual Report to Congress.

Summary

I. Welcome

LADY

- EIA views the Symposium as an opportunity to bring together different academic and non-academic interest that deal with energy.
- The Symposium should help EIA improve their work and report.
- EIA works under two basic constraints: (a) a logistics lag necessarily arises between final computer runs and the publishing of the report, and (b) EIA's policy is to avoid scenarios generated by varying energy policies.

II. Analytic Objectives and Study Design

LADY

- Forecast scenarios were designed to accommodate the idea of uncertainty in a second best sense by varying demand and supply curves by varying economic and geological conditions rather than national energy policies.

MYLANDER

- Next year's report will reduce the number of scenarios to three: a hi, base case, and low scenario based on different world oil price projections.
- Welcomes comments on how to make the report better able to serve users' needs.

III. Short-Term Energy Supply and Demand

CLARK

- Briefly reviews some important short-term projections.
- The short-term methodology is undergoing substantial change.

IV. Midterm Energy Supply and Demand

MYLANDER

- Reviews the 1978 midterm forecast and procedure.
- Describes key assumptions regarding energy prices, regulation, government policy, and projects underlying <u>all</u> projections.
- Discusses the methodology used in forecasting and establishing energy prices.

TAKAYAMA

- Explains the philosophy behind EIA's use of large scale, integrated, market equilibrating energy/economic models.

MORLAN

- Details the methodology of the demand side of the midterm system which is not discussed in the actual report.
- Describes the relative advantages and disadvantages of reduced form versus structural models and explains why EIA is moving in the direction of more structure in its models.

ALMON

- Compares EIA's midterm forecast to the midterm results of the University of Maryland INFORUM input-output model.
- Identifies data problems in residential, commercial, and industrial data bases.

HUDSON

- Lists several concerns regarding technical aspects of the midterm forecast in petroleum supply, conservation controls, and DRI energy price projections.
- Comments on the scenario design not providing a large enough uncertainty range and the lack of sensitivity analysis.
- Argues that from a strategy point of view, the forecasting procedure should rely on smaller, product-oriented models.

MACKENZIE

- Takes the view that EIA made a valiant attempt at the impossible; that instead of forecasting future energy demand and supply predicated on present energy policy and legislation, EIA should spend more time on what could happen in the future under alternative energy policies.

V. Long-Term Energy Supply and Demand

PEARSON

- Describes the LEAP model: a non-LP modular, heavily structured simulation approach.
- Identifies and discusses the fact that in the long term supply is not a constraint but the problem is in projecting demand.
- Long term is driven by GNP projections.
- Foresees high industrial demand and heavy use of electricity, generated predominantly by coal and nuclear.

HOFFMAN

- Feels long-term section of report should be doubled in number of pages devoted to it.
- Welcomes comparison of EIA's forecast to other models.
- Identifies categories of uncertainties that should be taken into account in the next ARC to provide a wider range of possible outcomes; uncertainties include the political, economic, and technical.
- Expresses concern over the industrial energy demand forecast and the need for more normative analysis.

KNAPP

- Discusses two basic reasons why it is necessary to look at the long run: (a) current prices of depletable resources depend on future expectations, and (b) current R and D will determine technology to be used in the future that will differentiate the midterm and long term.
- Argues for consistent methodology and assumptions between the midterm and long-term forecasts.

KNAPP (continued)

- Also sees the aggregation present in the industrial sector to be a poor view of the world: sees industry soaking up energy conserved by residential and commercial sectors.
- Sees more potential for natural gas supply and less for coal.
- Would like data on elasticities and sensitivity analysis for the user.

THOMPSON

- Concerned that all long-term projections show increased electrification, especially generated by nuclear and decreased reliance on natural gas.
- Expects significant natural gas supply response to deregulation and significant demand response to price for electricity and natural gas due to present underestimation of gas supply, electricity demand, elasticies, and electric-gas cross elasticity.
- The economy is on an inefficient energy path and will most likely stay on it.
- Need to related models better to real world behavior.
- Need to look at alternative possible energy/economy paths.

VI. Oil and Natural Gas

EVERETT

- Main handicap of midterm projection is the lack of an adequate resource appraisal from the U.S. Geological Survey.
- Discusses the principle inputs into the midterm range supply model.

O'NEILL

- Describes new methodologies being developed for simulating the on-shore and off-shore oil and natural gas exploration and development process.

ERICKSON

- The motivation for building and analyzing models ultimately is a policy concern.
- Though we do not know what the resource base is, we do observe it to be log-normally distributed.
- The current price of energy is historically low and rising, at the same time becoming more determined by poltiical events.
- EIA should be applauded for its modular approach which reveals our fundamental resource base ignorance and allows for the incorporation of new information and political constraints.
- The only way to reduce our resource base ignorance is through drilling activity.

HOLLOWAY

- Argues that the purpose of the report is to enhance government planning activities, thus, wonders why the report does not discuss policy implications of rising energy costs.
- Considers the methodology used in the report to be a hodge-podge of different methods leading to confusion about the interpretation of supply functions and preselected price paths.
- The report lacks empirical and conceptual support bolstering the model.
- Discusses the details of the oil and natural gas model; particularly the sensitivity of elasticities of supply to finding and drilling rates.

HOLLOWAY (continued)

- Proposes de-coupling oil and natural gas in the midterm model in addition to examining finding rate estimates more closely and improving our knowledge of the resource base characteristics.
- Would like to see explanation of underestimate of natural gas supply response.
- Would like to see development of models more closely related to actual industry drilling and investment behavior.

MURPHY

- The ARC should be primarily used for government decision making processes--both legislative and regulatory.
- A problem is that EIA's, as well as other, forecasts are pinned on the same DRI macroeconomic forecast.
- EIA's scenario range is of limited use because the user does not know the structural properties, the equations, or the elasticities of the model.
- EIA needs to expand the range of their scenario approach to provide a better conception of the large uncertainties inherent in future energy supply and demand.
- Would like to see supply and demand equilibrating approach of the midterm used also in the short-term model.

SCHLESINGER

- Considers the EIA gas forecast the most dire forecast the American Gas Association has seen.
- Finds the EIA supply forecast for conventional sources of natural gas to be consistent with AGA forecasts.

SCHLESINGER (continued)

- Feels that EIA underestimated the demand for natural gas by 6.2 quads in the midterm by underestimating impact of higher electricity prices, assuming strict Rule 2 interpretation of incremental pricing, assuming an excessively fast boiler back-out rate, and ignoring the return of previously curtailed industrial load.

- The effect of underestimating natural gas demand was to ignore possible unconventional sources of natural gas in the future.

- Recommends taking hard look at emerging policies on natural gas, environmental constraints on using other fuels, prospects for importing natural gas, and developing unconventional gas and synthetic fuels.

VOGELY

- With respect to an integrated oil and natural gas supply model, we need a geological occurrence model, an exploration model, and a development model.

- Policymakers need to evaluate models not in terms of impacts on the model itself but on the viability of the process the model is supposed to describe.

- The only way to gain knowledge about the oil and natural gas resource base is to drill and to do so on a random basis.

- The concept of a competitive supply curve makes little intuitive or economic sense.

VII. Coal

PAULL

- Reviews EIA's 1978 projections and presents main factors influencing coal supply results.
- EIA uses a supply curve segment of the national coal model called RAMC--Resource and Mine Costing submodel to generate supply curves which are aggregated for the midterm model.
- Identifies key assumptions and variables in the coal supply model.
- Describes uncertainties associated with the resource base, future demand, and capital and labor productivity in the coal industry.
- Sees growing use of coal resulting from increased growth in electricity consumption and industry reaction to the Fuel Use Act.

GORDON

- Modelers spend too much time looking at basic logic to the models and comparing them to other models.
- Basic problem is the inadequate demonstrated resource base put together by the U.S. Bureau of Mines forcing modelers to adjust data on an ad hoc basis.
- EIA is too conservative in generating its forecast range through the scenario technique and lacks sensitivity analysis.
- The forecasters have been overly political in accepting the estimated or desired impact of present regulation and legislation.
- EIA has been overoptimistic about the development of synthetic fuels and the industrial use of coal.

HOLMES

- The models should be as accurate and timely as possible and reflect real world assumptions and expectations.
- EIA and National Coal Association forecasts tract well in the short run, but diverge in the midterm; NCA projects lower coking coal consumption and sees supply exceeding demand through 1990.
- Disagrees particularly with the estimated positive effects of the Fuel Use Act and the estimates of coal consumption in producing synthetic fuels.
- Post 1990, oversupply will likely continue but changes could lead to an undersupply situation.
- Suggests improving data on industrial use of coal, spelling out report limitations regarding data and assumptions used, speeding up the printing and dissemination process, bridging the gap between published forecasts and the real world, and seeking greater industry input.

EYSTER

- EIA is constrained not to second guess government policy.
- EIA faces a crucial validation problem in using industry data and needs to avoid being captured.
- EIA would like to conduct more sensitivity analysis but the limited analysts' time to carry out such analyses is the primary constraint rather than computer time.
- Work is being done to improve the demonstrated resource base for coal and the mine costing program is being revised to focus on sensitivity analysis and uncertainty.

VIII. Nuclear

REYNOLDS

- A pipeline approach is used to project nuclear power plant capacity through the analysis of past data to develop trends regarding the future capacity range.
- Constraining factors on future nuclear capacity include financing availability, electricity demand, and competition from coal.
- EIA sees rapid nuclear growth after 1995 with fusion as a long-run development in the early 2000's.
- EIA is optimistic overall on the use of nuclear assuming electricity load grows considerably, regulatory lag is mitigated, along with substantial public support.
- A nuclear moratorium scenario resulted in increased use of coal and oil for electricity generation, while electricity growth grew at a slightly slower rate.

CLARK

- In predicting nuclear fuel requirements the level of installed capacity, mix of generating equipment, power plant capacity factors, thermal plant efficiencies, and ratio of uranium mined to enriched uranium were all taken into account.
- Developed an expectations based market model of the uranium market.
- Discusses the results in the 1978 ARC nuclear chapter.

LARSON

- Argues that with the recent sharp rise in uranium prices, cost of uranium is an important part of the cost of nuclear generated electricity.

LARSON (continued)

- The rise in interest rates and environmental costs have added significantly to the cost of nuclear power.

MUNTZING

- Given that the report is used for decision-making purposes, asked if Congress, DOE, or OMB used it?
- Considers Three Mile Island to be potentially good for the industry if the industry can weather the crisis.
- In light of the Kenney report, outlined eight principles of importance regarding the nuclear power option.
- Expected orders for nuclear power plants to build again during the 1980s and 90s.

IX. Electricity

O'BRIEN

- The model used is the electric utility dispatch model, a submodel of the MITEFS, which makes optimal decisions on dispatching plants to operation, as well as construction of new plants, based on minimization of marginal electricity production costs.
- The model incorporates capital cost, load duration curve, and regional reserve margin components.
- Assumptions used regarding federal and state regulation including the Fuel Use Act, Clean Air Act, and PURPA, along with FERC fuel conversion assumptions and capital cost assumptions were reviewed.
- EIA forecast results were compared to other forecasts.

CLARK

- Reviewed the special probelms of nuclear power including projected capacity and uranium and constructions costs.

BAUGHMAN

- Considers EIA to have neglected the impact of state utility rate regulation on the utilities' ability to attract the necessary capital to promote expansion with EIA's projected range of utility expenditures.
- Feels EIA has also neglected the difficulty utilities face in convincing state regulatory commissions of the need for additions to capacity in light of historically high reserve margins.
- System reliability is given too little attention in the report.
- The EIA utility dispatch model does not correspond to actual utility decision-making especially with regard to the treatment of fuel cost in the capacity expansion logic.
- Lack of complete attention is given to maintenance scheduling problems under higher predicted load conditions.

KARAGANIS

- The Edison Electric Institute feels that EIA is too optimistic on its midterm economic and energy forecast.
- Major problems in the electricity forecast stem from an overoptimistic GNP growth rate, uncertainty regarding future financing availability and fuel choice, and an overly simple modeling of reliability.
- Recommends outsiders be able to comment on or participate earlier and more directly.

EYSTER

- EIA is trying to bring into the system a model of the state regulatory process.
- The effects on reserve margins from improved load factors were incorporated based on an EPRI study.
- Three Mile Island occurred after the write-up of the report.
- EIA has been projecting lower growth rates for electricity than the economy in general for the last five years and has been very consistent on this point.

X. Energy Uses

MOONEY

- Compares the demand side changes between the 1977 and 1978 ARC: major changes being revisions of industrial data and GNP growth rates and conservation effects in residential and transportation uses.

BELL

- Compares the Pace Company methodology and results to EIA's forecast.
- Expects world oil supply not to exceed 62 million barrels/day by the year 2000 and to be fairly inelastic to price.
- Implications include continuing escalations of real oil prices, continued though less dramatic improvements in industrial conservation, continued transportation efficiency improvements, but higher household energy consumption due to increased electrification.

CASTELLANI

- Industrial energy consumption per unit of output has declined 16 to 17 percent since 1973.

CASTELLANI (continued)

- National Association of Manufacturers expects continued conservation from housekeeping in light of 30 dollar per barrel oil and major energy reductions beginning in the late 1980's when technical process changes will take place.
- Fuel choices in the future will be made less on economic criteria and more on political induced flexibility criterion.
- Industrial use of coal is declining because it is too expensive to obtain and burn and that unless environmental restrictions are relaxed, little additional industrial use of coal will occur.
- Future industrial use of natural gas will depend on future regulatory policies regarding its use and the use of alternative fuels.
- Industry is likely to be forced into using higher cost electricity to a greater extent, promoting additional conservation.
- Industrial use of oil, again, will be dependent on future national energy policies regarding its use.

EASH

- The highway mode will continue to dominate transportation energy use comprised of automobile and truck usage.
- Fuel consumption calculations for auto and truck fleets are based on fleet age distribution, model type distribution, engine type, and average miles driven by type.
- EPA test-cycle driving profile as presently constituted does not reflect expected future changes in the ratio of urban to rural travel, average highway speeds, or discretionary travel.

EASH (continued)

- The submodel of vehicle miles traveled being a function of disposable income, gasoline prices, and employment levels is based on time series data not reflective of the future urban/rural travel split or reduced average speeds resulting from a poorer, more crowded highway system.
- Individuals appear to have a relatively constant time budget for travel.
- Fuel price elasticities can be measured by type of trip and appear to be very elastic for work related trips and relatively less elastic for social/recreational trips.
- Recommends the development of a more realistic transportation sector to be built into the midterm model to account for suppressed discretionary travel and intermodal shifts.

GUERIN

- Suggests going to a maximum of three scenarios--a high, base case, and low.
- EIA should specifically develop a scenario or sensitivity analysis with regard to President Carter's imported oil cap.
- Would like to see residential and commercial sectors disaggregated and wondered how EIA developed the base line statistics for these two areas.
- Finds the industrial energy use data base a complete mess and, though hesitant to suggest the need for more data, supports the development of a boiler inventory.
- Sees continued industrial efficiency gains in the use of energy and little prospect for co-generation in the near future.

XI. Energy Impacts

SANDOVAL

- Provides a general overview of the 1978 ARC impact analysis.

CURTIS

- Economic impacts are generated through the use of an iterative process whereby DRI trend forecasts are inputed into the MEF System to generate demand curves which are plugged into an LP system to obtain prices and re-iterated.
- Due to the small number of macroeconomic variables that can be re-fed into the macroeconomic model, EIA is getting a smaller than desirable range of possible impacts.
- Future improvements will result from the use of a more detailed DRI model.

PECHAN

- Discusses the characteristics of environmental issues faced in projecting the future energy system of the country.
- EIA's objectives are to identify significant impacts, quantify changes in environmental conditions, and provide qualitative insights as well.
- EIA projections of criteria air pollutants show total suspended particulates, sulfur oxides, and hydrocarbons remaining relatively constant for the next ten years, while nitrogen oxides increase significantly and carbon dioxide decreases.

BENTZ

- Argues that more work needs to be done on alcohol fuels given the present energy supply uncertainties and lack of adequate energy transportation infrastructure.

MOSS

- Finds ARC to contain useful information on environmental impacts but falls short with respect to several impacts of increasing concern and fails to project different impacts of alternative proposed policies.
- The report needs to be expanded to include air pollution impacts of pollutants not presently covered by legislation, water supply impacts, solid waste generation, and carbon dioxide.
- Suggests analyzing environmental impacts under three alternative scenarios: extrapolation of existing law, implementation of industry viewpoints, and implementation of environmentalists' viewpoints.
- The report should also include comparison of relative impacts and the cost of achieving them for different regulatory and economic schemes.

ROTHSCHILD

- Finds the report weak in projecting household expenditures, forecasting world oil prices, and expressing results in geographical detail.

Conclusions

The Energy Information Administration was congratulated by many reviewers and participants for initiating the Symposium to Review Volume Three of the 1978 Annual Report to Congress. Many expressed interest in future opportunities to exchange ideas and information. This first symposium generated much discussion regarding the purpose of the ARC, ARC scenario designs, EIA model building, data collection needs, ARC projections, and the style of the report. This concluding section will present both general and specific comments made by the reviewers and EIA personnel on these aspects of EIA's work and report.

<u>Purpose of the ARC</u>

EIA is mandated by Congress to provide, in a report to Congress, forecasts of short-, mid-, and long-term energy supply and demand. In preparing these forecasts EIA, by legislative mandate and in an effort to remain as neutral and independent as possible, has adopted the policy of generating energy demand and supply forecasts by varying economic and geological assumptions under existing policy, legislation, and regulation.

A significant number of reviewers commented that the purpose or usefulness of the report is, or ought to be, in analyzing effects of alternative public policies towards energy; that the report should be used in government planning with respect to energy policy concerns.

Several reviewers specifically singled out the long-term analysis as being particularly useless, primarily because of the large range of uncertainty that naturally surrounds long-range forecasting. Other reviewers, on the other hand, argued that long-run decisions must necessarily be made in the private and public sectors, and a best guess long-run view of energy and demand is better than none at all.

The Energy Information Administration argued that the report did serve policy makers by providing them with a strong base case under existing policies which provided impact information for varying economic and geological conditions. Policy makers could then judge the effect of present policy and proposed policy. This difference in opinion was not resolved, nor is it likely to be resolved in light of EIA's legislative mandate, and spilled over into the discussion of scenario design.

Scenario Design

In the 1978 Annual Report to Congress, EIA essentially made one forecast. The forecast for the midterm was expressed as a range of five possible scenarios. The scenarios differed by economic assumptions on the energy demand side and geological assumptions on the energy supply side. On the demand side, variability was introduced by varying the expected GNP growth rate, while on the supply side exploration, development, and production estimates were varied to arrive at a high, base case, and low demand and supply curve. The intersection of the high, base case, and low demand and supply curves formed the basis for the five scenarios (high demand-high supply, low demand-low supply, high demand-low supply, low demand-high supply, and base demand-base supply), which jointly constituted the forecast. The scenarios all assumed the same regulatory and legislative environment--that of present U.S. policy.

Most reviewers felt the scenario approach was a good one. Three reviewers favored reducing the basic scenarios to three rather than five because they felt more than three scenarios were not read. EIA announced that it had already come to the same conclusion and that the 1979 ARC would only present three scenarios based on high, base, and low estimates of future world oil prices.

Though it was agreed that fewer scenarios were desirable, over one-third of the reviewers criticized the report for providing too small a range of possible forecasted outcomes and for the lack of reported sensitivity analysis. Three speakers went on to suggest that EIA should report the elasticity estimates so that at least the user could conduct his or her own sensitivity analysis.

EIA responded that resource constraints, particularly analysts' time, severely limited EIA's ability to conduct and report sensitivity analysis, along with report page limitations, and that the reporting of elasticities was not justified given their irrelevance in terms of forecasting compared to explanatory work. Again, many reviewers wanted EIA to conduct policy-oriented scenarios, while EIA indicated they did not feel that was their role and should be left to the policy groups in the U.S. Department of Energy.

Model Characteristics

The modelling approach chosen by The Energy Information Administration was the development of a large-scale, modularized market equilibrating model driven by DRI economic forecasts. The model is designed to promote the greatest flexibility in adjusting the forecast to changes in economic and policy environments. Current developments within EIA point toward the inclusion of more structure in the model and the improvement of computational speed in making model runs.

The question of model design was not a major issue among the reviewers. Several considered the large-scale, integrated model to be too big, resulting in slow turnaround, limited sensitivity analysis, overemphasis on model design versus model output, and potential lack of use or understanding due to overcomplexity. However, even those who felt that model size was not an important consideration did express suggestions for improving the model. The suggestions included: (a) the need to bridge the gap between the model and the real world to better depict actual economic behavior versus theoretical behavior; (b) the need to resolve confusion and inconsistant interpretation or use of the supply curve concept, especially under competitive market conditions; and (c) the need to use consistent methodology in forecasting for the midterm and the long term.

To help achieve the first suggestion of making the model better depict reality, reviewers from industry trade associations advocated greater review and/or participation on the part of industry in construction of some of the models' modules. Members of EIA, however, considered such active participation as potentially conflictive with its independent status.

Data and Data Collection

The inadequacy of data was a dominant concern among many of the reviewers, both on the demand and supply side for energy. On the supply side, the lack of knowledge about the resource base for oil, natural gas, and coal was viewed as a considerable obstacle to accurate modelling of these supply sources. It was suggested that oil and natural gas should be modelled separately and that exploration, development, production, and pricing modules be constructed. In response, EIA indicated it was already moving in the direction of exploration and development models for on-shore and off-shore oil and natural gas.

On the demand side, there was almost universal agreement that the aggregate approach to modelling industry energy demand and the use of utility bills to classify residential versus commercial energy consumption were wholly inadequate. The call for additional data from industry met with skepticism, though, because of the difficulties in measuring industry energy usage by SIC classifications and the proprietary nature of the data. EIA also felt validation problems might arise but was sympathetic to the view that more detailed data on energy consumption by industry would be very desirable. One suggested move in this direction was the creation of an industry boiler inventory.

Assumptions and Results

Discussion of data shortcomings, model characteristics, and scenario designs naturally led to evaluation of EIA forecasts by the reviewers. The reviewers identified the following forecasts to be either over-optimistic or over-pessimistic:

Natural Gas Supply. Underestimated due to underestimated natural gas demand. Natural gas demand was underestimated because electricity prices were projected to rise at too moderate a rate, the impact of incremental pricing was overstated, conversion to alternative fuels by industry was over-optimistic, and the return of previously curtailed industrial use of natural gas was ignored. The understatement of natural gas demand led to the ignoring of supplemental supplies of natural gas and, thus, the understatement of natural gas supply in the midterm forecast.

Electricity Growth Rate. Overestimated as a result of an over-optimistic DRI-projected GNP growth rate. In addition, it was felt by the reviewers that financing difficulties arising from state commission regulatory lag, the difficulty in justifying additional capacity in the face of high reserve margins, and the effect of higher loads on reliability and maintenance schedules all would dampen the growth of electric power.

Nuclear Capacity. Over-optimistic in the long term in the base case scenario. Though the report included a nuclear moratorium scenario, which probably pessimistically allowed no new nuclear power plants to enter the construction pipeline, the base case appeared to overstate nuclear capacity by over-optimistically assuming rapid electricity load growth, reduced regulatory lag, mitigated construction and safety problems, and complete public support.

Coal Demand. Over-optimistic demand and, thus, coal supply because EIA misread the impact of the Fuel Use and Clean Air Acts, overestimated electricity growth and overstated use of coal resulting from proposed synthetic fuel program. The reviewers held this position for the midterm energy forecast; beyond the midterm, coal demand and supply could conceivably increase dramatically from the synthetic fuel program and the diminished use of nuclear power.

Synthetic Fuels. Overstated with respect to the time required to develop and commercialize synthetic fuels, which was considered too short as assumed in the forecast.

Industrial Use of Fuel. Overestimated in the long run by ignoring trends in industrial energy usage per unit of output which had been declining, and were expected to further decline, with higher world oil prices and the neglect of future technical process changes to reduce energy consumption.

Transportation Fuel Use. Overstated in light of likely future shifts in urban/suburban location toward urban nuclei, lower average speeds, and over-simplified modelling of the transportation sector.

Report Structure

Finally, a few comments were made about the structure of the report itself. Some, but not many, reviewers felt that Volume Three was too big. Most of the reviewers that commented, however, wanted to see the balance of the report changed, emphasizing the long-term analysis more.

Documentation in the report was considered excellent, though a number of reviewers considered the comparison of the EIA forecast to outside forecasts was not very important and could have been left out of the report.

Overall, the Symposium to Review Volume Three of the 1978 Annual Report to Congress was considered to be a success. It offered an opportunity for a diverse group of interested energy experts to publicly express their analysis of the Energy Information Administration's work and report. The review highlighted many areas of agreement and disagreement with EIA's forecast and opened up the possibility for a wider range of future thought, feedback, and cooperation that should enhance and make more publicly useful EIA's forecasting activity.