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Report to Robert W. Fri, Acting Administrator, Energy Research and Development Administration; by Monte Canfield, Jr., Director, Energy and Minerals Div.

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Net energy is generally defined as the amount of energy available for consumption from a resource after subtracting the energy expended to locate, mine, transport, refine, convert, and deliver it to the customer. The Energy Research and Development Administration (ERDA) has not used net energy analysis in analyzing and considering net yields of new energy technologies as much as intended by the Federal Nonnuclear Energy Research and Development Act of 1974. Findings/Conclusions: The application of net energy analysis to research, development, and demonstration is a relatively new concept and the state-of-the-art and other problems have impeded its development and effective use. ERDA officials have not made much use of net energy analysis for planning or other purposes because, until its problems are resolved, the results will not be reliable. Recommendations: The Administrator of ERDA should: develop a formal, comprehensive management plan, including objectives, milestones, and target dates for the timely resolution of the problems associated with net energy analysis; develop procedures for implementing the plan and decision points for evaluating progress; aggressively implement the plan and annually report to the Congress on the status and results of these efforts as part of the annual authorization and appropriation process; and develop plans and procedures to use net energy analysis to the extent practicable in planning and carrying out energy research, development, and demonstration. (SC)

UNITED STATES
GENERAL ACCOUNTING OFFICE

Net Energy Analysis: Little Progress And Many Problems

Energy Research and Development Administration

Net energy is generally defined as the amount of energy available for consumption from a resource after subtracting the energy expended to locate, mine, transport, refine, convert, and deliver it to the customer. GAO found that ERDA has not used net energy analysis as much as intended by the Federal Nonnuclear Energy Research and Development Act of 1974 (Public Law 93-577) in analyzing and considering net yields of new energy technologies being developed. The application of net energy analysis to RD&D is a relatively new concept and state-of-the-art and other problems have impeded its development and effective use.

GAO noted several opportunities for ERDA to (1) expedite the development and use of this concept and (2) assist the Congress in evaluating the progress and problems relative to carrying out the requirements of the act and in making more informed decisions on national energy matters.

EMD-77-57

AUGUST 10, 1977

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

ENERGY AND MINERALS
DIVISION

B-178205

The Honorable Robert W. Fri
Acting Administrator, Energy Research
and Development Administration

Dear Mr. Fri:

We have completed our survey of the Energy Research and Development Administration's (ERDA) activities relating to the development and use of net energy analysis as an aid in planning and carrying out this Nation's energy research, development, and demonstration (RD&D) efforts.

We found that ERDA has not used net energy analysis as much as intended by the Federal Nonnuclear Energy Research and Development Act of 1974 (Public Law 93-577). The application of net energy analysis to RD&D is a relatively new concept and state-of-the-art and other problems have impeded its development and effective use. ERDA officials said they had not made much use of net energy analysis for planning or for other significant purposes because, until its problems are resolved, the results will not be reliable. Our findings are discussed in more detail in the enclosure.

Although ERDA has been supporting studies involving net energy analysis, we noted some opportunities for (1) expediting the development and use of this concept and (2) assisting the Congress in evaluating the progress and problems relative to carrying out the requirements of the Federal Nonnuclear Energy Research and Development Act of 1974 and in making more informed decisions on national energy matters. Specifically, we are recommending that you:

--Develop a formal, comprehensive management plan, including objectives, milestones, and target dates for timely resolution of the problems associated with net energy analysis.

--Develop procedures for implementing the plan and decision points for evaluating progress. One of

the decision points should be a complete assessment of the potential usefulness of net energy analysis, including the extent to which it can be used as a reliable energy policy and decision making tool.

--Aggressively implement the plan and annually report to the Congress on the status and results of these efforts as part of the annual authorization and appropriation process.

--Develop plans and procedures to use net energy analysis to the extent practicable in planning and carrying out energy RD&D.

We made our survey primarily at ERDA headquarters in Washington, D.C., and Germantown, Maryland. We also interviewed officials within the Federal Energy Administration, the National Science Foundation, and the Department of the Interior concerning their use of net energy analysis, and we contacted prominent net energy analysts and practitioners at the following nonfederal organizations:

--The Colorado Energy Research Center

--The Colorado School of Mines

--The University of Oklahoma

--The University of Illinois

--The University of Florida

--The Du Pont Chemical Corporation

--The Electric Power Research Institute

A draft of this report was furnished to ERDA officials responsible for the development of net energy analysis. Their comments were considered and changes were made in the report where appropriate.

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We are sending copies of this report to the Director, Office of Management and Budget; the Chairman, House Committee on Appropriations; the Chairmen, House Committee on Government Operations and Senate Committee on Governmental Affairs; the

Chairman, Subcommittee on Public Works, Senate Committee on Appropriations; and the Chairman, House Committee on Science and Technology.

As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We appreciate the courtesy and cooperation extended to our staff during the survey.

Sincerely yours,

Monte Canfield, Jr.
Director

Enclosure

ENCLOSURE

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NET ENERGY ANALYSIS: LITTLE PROGRESS AND MANY PROBLEMS

Energy Research and Development Administration

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ENCLOSURE

NET ENERGY ANALYSIS: LITTLE PROGRESS AND MANY PROBLEMS

BACKGROUND

Net energy is generally defined as the amount of energy available for consumption from a resource after subtracting the energy expended to locate, mine, transport, refine, convert, and deliver it to the consumer. Simply stated, net energy analysis is the study of the amount of energy returned on energy invested to get the energy. In certain technologies, the consumption of energy by the processes and facilities necessary to produce and deliver the energy to the consumer may account for a major portion of the yield. Some studies have indicated that certain technologies have negative net energy yields--that is, the energy invested exceeds the energy obtained.

Although the concept of net energy has existed for more than 20 years, it was popularized only in late 1973 and 1974 following the Arab oil embargo. Additional impetus was given to the concept following enactment of the Federal Nonnuclear Energy Research and Development Act of 1974 on December 31, 1974.

The purpose of the act was to establish within the Energy Research and Development Administration (ERDA) a comprehensive, national program of basic and applied research, development and demonstration (RD&D) for all potentially beneficial nonnuclear energy sources and utilization technologies. The act established a number of principles to be followed by ERDA in carrying out the program, including a requirement that ERDA make use of the net energy concept. Section 5(a)(5) of the act states:

> "The potential for production of net energy by the proposed technology at the stage of commercial application shall be analyzed and considered in evaluating proposals." (Underscoring added.)

By including this requirement, the Congress intended that ERDA analyze and consider the net, as opposed to the gross, yield of new energy technologies in assigning priorities for Federal encouragement of commercial application.

ERDA's efforts to develop net energy analysis are primarily centered in the Office of the Assistant Administrator for Planning and Analysis. This office contracts with various universities, research institutes, and private industrial

firms for studies of the net energy concept. Such studies for the most part are intended to develop a uniform methodology for applying net energy analysis throughout ERDA. The following table shows the funds provided by this office to contractors during fiscal year 1976 through the transition quarter and the estimated funding for fiscal year 1977 for these studies.

Office of Planning and Analysis
Funding for Net Energy Analysis

Fund recipients	Fiscal year 1976 (note a)	1977	Total
Institute for Energy Analysis	$220,000	$193,000	$413,000
University of Illinois	73,000	80,000	153,000
Development Sciences, Inc.	56,000	-	56,000
Undesignated	-	50,000	50,000
Total	$349,000	$323,000	$672,000

a/Includes the transition quarter.

ERDA'S USE OF NET ENERGY ANALYSIS

ERDA has not made much use of net energy analysis as an aid in the overall planning of this Nation's energy RD&D efforts or in evaluating and assigning relative priorities to proposed RD&D. Although ERDA's April 1976 "National Plan for Energy Research, Development, and Demonstration: Creating Energy Choices for the Future" (ERDA 76-1) contains several references to net energy analysis, the plan merely notes the importance of net energy analysis as an aid to program planning, refers to the results of two previously completed net energy studies, and includes a net energy analysis of nuclear power. We found no indication that the studies referred to in the plan had been used as an aid in overall energy RD&D planning or for any other significant purpose.

We reviewed the procedures and criteria used by several energy program divisions for establishing research priorities and evaluating and selecting research proposals. These included divisions within the Offices of the Assistant Administrators for Fossil Energy; Solar, Geothermal, and Advanced Energy Systems; and Energy Conservation. Although these divisions have considered net energy analysis, the extent of

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consideration varied greatly and only those divisions in the Office of Fossil Energy made any use of the concept in determining program content.

The Office of Fossil Energy appears to have made substantial progress in using net energy analysis. Fossil Energy officials responsible for program planning and analysis said they routinely used net energy analysis, in conjunction with other forms of analysis, in considering strategic issues related to fossil energy alternatives. They pointed out that only those processes having positive net energy yields are continued in the Fossil Energy program.

The approach taken by Fossil Energy has been to develop net energy analyses for the production of fossil fuels including coal, natural gas, oil shale, and petroleum. The analyses are made for the various pathways associated with resource extraction, transportation, and processing; transportation of the processed fuel; and, conversion, distribution, and end use.

The analyses are further broken down into modules covering discrete energy processing steps. For example, the net energy analysis for the production of synthetic natural gas includes modules for (1) surface and underground coal cleaning, with and without reclamation; (2) coal transportation using truck, train, barge, and slurry pipeline; (3) coal preparation including cleaning and beneficiation; and (4) gasification through pressurization and introduction to the pipeline distribution system.

For the most part, however, the net energy studies made under Fossil Energy auspices have been based on overall or generic processes, such as for the gasification module in the example cited above. Fossil Energy program divisions generally do not make specific net energy calculations for the various alternative processes that are the subject of specific RD&D proposals submitted to the divisions for funding. Instead, these divisions rely on analyses of capital equipment specifications, material balances, and heat balance which is an engineering technique for determining the efficiency of the proposed process.

In commenting on a draft of this report, Fossil Energy officials made the following statement relative to calculating net energy yields for each proposed process.

> "The analyses that are performed by the divisions for specific processes can be aggregated readily into a full trajectory net energy analysis by the [Fossil Energy] Planning and Analysis staff as required. In the * * * example discussed above,

only the gasification module results will change as a function of the process being considered. All other modules (mining, transportation, preparation) would remain the same. Thus, in comparing alternatives, the division can concentrate solely on the processes under consideration.

"If a full net energy trajectory is needed for a specific process, the staff can readily produce one from existing modules and the division's analysis. The major contribution would come directly from the division's heat balance. The material balance and capital equipment specifications would be used with an input/output table to obtain these energy subsidies. This aggregation of division analysis into a full net energy trajectory would, however, only be done when a requirement is levied from the outside. This is the most efficient way to proceed since net energy analyses have shown only positive net energy yields from processes in the RD&D program. * * *"

Fossil Energy officials further advised us that although specific calculations of net energy yields are not made for each proposed process, the program managers in the Fossil Energy divisions are conscious of the overall net energy results for the various generic processes in their evaluations of specific proposals.

In contrast, program divisions within the Office of Solar, Geothermal, and Advanced Energy Systems did not appear to be giving much consideration to the net energy yields of the various technologies under development, including for example, the Division of Solar Energy which is developing seven major technologies considered to be technically feasible for harnessing solar energy.

--Solar heating and cooling in residential and commercial buildings.

--Agricultural and industrial process heat applications.

--Production of fuels from biomass.

--Photovoltaic conversion systems.

--Wind energy systems.

--Solar thermal conversion systems.

--Ocean thermal energy conversion systems.

Solar energy officials told us that although some studies disclosed net energy yields of certain solar technologies, the division has not placed much reliance on them because of uncertainties regarding the appropriateness of the methods the studies employed. These officials told us that net energy yields, therefore, are not used within the division for establishing priorities among the solar technologies. Instead, the criteria used include such variables as the potential short-term and long-term impacts of the technology, market readiness, technology readiness and complexity, degree of industrial capability, social and economic impact, and nontechnical/noneconomic barriers.

The Divisions of Magnetic Fusion Energy and Geothermal Energy similarly were not making use of net energy analysis. An ERDA official told us that the magnetic fusion program has not progressed to the point where a meaningful net energy study could be performed. He said that before such a study can be made, the RD&D must reach a point where a fusion plant can be conceptualized, and this cannot be done until scientific feasibility is demonstrated.

A geothermal energy official told us that some net energy studies had been made but the results were thought to be unreliable for use within the division. He added, however, that the division is now beginning to recognize the potential usefulness of net energy analysis and has recently begun to consider its possible application in the geothermal energy program.

Although the conservation program divisions covered during our survey appeared to have rather formal criteria for evaluating proposed projects, the criteria did not include their net energy yields. For example, the Division of Conservation Research and Technology has developed a formal project appraisal methodology for evaluating proposed projects against predetermined weighted criteria. The criteria include such factors as energy savings, technical risk, cost, uniqueness, resource availability, and legal, social, institutional, and environmental effects. The division, however, has not included net energy as one of the appraisal criteria and has no plans for doing so.

The Divisions of Buildings and Industry and Industrial Energy Conservation similarly were not using net energy analysis. These divisions use a computer model to rank the priorities of research proposals. The model, in turn, is based on a selected set of criteria which includes the

relative savings in energy efficiency of the proposed system compared to the existing conventional system. Officials within these divisions, however, stated that they were planning to modify the data base and to program this model to provide a net energy analysis capability.

PROBLEMS IMPEDING DEVELOPMENT AND USE OF NET ENERGY ANALYSIS

Officials in ERDA and other Federal agencies and prominent net energy analysts and practitioners at universities and research institutions told us that numerous problems are impeding the development and effective use of net energy analysis. Although these problems are highly interrelated, we have grouped them into three general categories: (1) state-of-the-art problems; (2) inconsistent results of net energy studies; and (3) philosophical differences over the potential usefulness of the net energy concept.

State-of-the-art problems

The principal state-of-the-art problems which we identified were inconsistencies in the boundaries selected for net energy studies, a lack of a standardized approach to making such studies, and inadequate data bases. Such problems have resulted in widely varying differences in the results of net energy analyses and difficulties in making meaningful comparisons among the various study results.

Inconsistent boundaries

According to ERDA officials and net energy practitioners, the most difficult problem related to net energy analysis is selecting appropriate boundaries for the system under study. This involves identifying the processes and activities associated with the production and distribution of fuels and energy in the various commercial forms used by society.

Some studies have limited these boundaries to the energy required to extract, process, transport, and convert the resource to the point of mass distribution to consumers. Other studies have included the fuel resource that was not recovered at the point of extraction and the losses incurred during processing. Other studies have even attempted to include the energy expenditures associated with the labor force and other human activities in the production and distribution processes, such as the energy costs for transporting the labor force to and from their jobs and the energy costs of building new communities in remote geographical areas.

Lack of standardized approach

Net energy studies to date have generally centered around one of three different approaches: (1) process analysis, (2) input-output analysis, or (3) eco-energetics.

In studies using the process analysis approach, many of the processes which make up the energy system are identified in detail, along with the various inputs associated with each process. These inputs are usually stated in terms of equipment, materials, and energy. The researcher then estimates an energy value for each input and compares the total for all inputs to the total energy produced.

Studies using the input-output analysis approach are based on the dollar transactions within the economy. The researcher converts dollars to energy, such as Btu's per dollar, for various goods and services as they flow through the economy. The data are presented in a table enabling the researcher to see at a glance the disposition of the energy output of various industries and how much energy input each industry draws from the output of other industries within the economy.

The eco-energetics approach to net energy studies is not widely understood. ERDA officials, however, say it is much more sophisticated and encompassing than either of the first two approaches. According to practitioners using this approach, it attempts to give recognition to the fact that the natural eco-system performs enormous services for society without active human intervention and that, deprived of these services, substitutes have to be provided often at a great expenditure of energy. Researchers using eco-energetics attempt to identify for each energy system under study the energy expenditures for both human activities, such as physical work and man's impact on the environment, and the energy input from nature, such as air and water purification. For example, if grasslands were converted to strip mining, this approach would assign energy values to the (1) human labor required to perform strip mining, (2) natural air and water purification processes inherent in grasslands, which would no longer be available, and (3) effort and materials required to return the land to its original state.

ERDA is developing a fourth approach which is essentially a hybrid using both process analysis and input-output analysis. Officials in ERDA's Office of Planning and Analysis said the best data and techniques from the two approaches would be combined into this hybrid approach. They pointed out this approach would recognize that the preferred way to compute direct energy input is through process analysis whereas the most efficient

procedure for computing indirect energy input is through input-output analysis. For example, in determining the energy impact on the Nation of constructing 100 nuclear powerplants, the direct energy requirement derived from process analysis could be integrated with the input-output analysis table to trace the energy flows through the economy and to identify what energy sectors would be affected and to what extent.

Inadequate data bases

The inadequacy of the data bases needed for making the studies is another major problem inhibiting the development and use of net energy analysis. Some net energy analysts and practitioners said their studies have often been hindered by a lack of reliable, up-to-date data on the energy consumed in the various processes for providing goods and services in the economy. For example, in determining the net energy yield of coal-fired electric generating plants, they have experienced difficulty in obtaining the energy values for certain inputs, such as, the number of Btu's in a machine used for mining the coal and in the concrete produced for use in constructing the powerplant.

This situation exists because energy data often are not compiled for each of the various processes that raw materials pass through from the time they are mined until they are finished products. Also, when data was available, it was often of questionable use because it was either old or not on a regional or site specific basis. The energy consumption data for certain products also may vary because they may be produced by different processes with varying degrees of energy intensity.

As a result, some net energy studies have been criticized from the standpoint that the data used was either out of date or inappropriate. In addition, studies of a given technology have shown varying results because of the different assumptions made regarding the data bases for such studies.

Inconsistent results of net energy studies

Several of the net energy analyses made to date by prominent net energy analysts and practitioners have yielded widely varying results. As an illustration, the following table shows net energy yield ratios for selected technologies based on two studies which used different methodologies and boundaries. Similar differences were noted in comparing results of other studies.

Energy technology	Ratio of energy yield to energy input: Study A	Study B
Strip-mined coal	55.6 to 1	10.[illegible] to 1
Oil shale	25.6 to 1	Negative net energy yield
Geothermal power	7.7 to 1	57.0 to 1
Nuclear fission	4.1 to 1	2.7 to 1
Solar electric	4.2 to 1	Negative net energy yield

Such vastly different results lead to confusion and suspicion concerning the reliability and competence of the studies. This situation, in turn, tends to discredit net energy analysis and may impede its development into a useful tool for energy planning and policymaking.

Potential usefulness of net energy analysis

Our survey showed that philosophical differences concerning the potential usefulness of the net energy concept in analyzing technology options are substantial.

Proponents' views

Proponents of the concept believe net energy analysis has great potential for making a major contribution in (1) energy planning, (2) evaluating the net energy yields of competing technologies, and (3) determining priorities among competing technologies and among projects within a given technology.

They contend that net energy analysis has an advantage over the more widely used economic analysis in that net energy yields are stated in physical units of measurement, such as Btu's, which do not fluctuate over time due to inflation. Cost-benefit studies and other economic analyses using money must be adjusted for future inflation, which is difficult to predict.

This physical basis for comparison also has the potential for highlighting changes in the energy being expended to get energy. This is particularly important where changes in net energy are not reflected by changes in prices or other determinants in the marketplace. For example, a recent analysis disclosed that the net energy yield of domestic crude oil has declined to one-tenth of its original yield during the past 40 years, while crude oil prices remained relatively steady.

Thus, although the price of crude oil was not giving the Nation an accurate indication of the increased energy needed to get that energy, a series of net energy analyses, performed over a period of time, could have identified this change.

Proponents also point out that the immediate application of the concept even on a limited basis would be useful. For example, although the net energy yield ratio of a single technology would have little meaning by itself, if that ratio was declining over time or was near 1 to 1, it could serve as a warning that the technology under observation may not be producing in accordance with plans or expectations.

Proponents of the net energy concept generally emphasized, however, that net energy analysis is not expected to eliminate the need to consider the traditional factors in assessing technical programs and project priorities; rather they believed the concept should be used to provide supplementary information for making such assessments. They pointed out that social, environmental, political, and economic ramifications of energy technologies cannot be ignored. For example, a technology having a high net energy yield in comparison to other technologies would signal the need for intensive development of that technology under a scenario where net energy analysis was the only consideration given; however, the environmental and/or economic implications might be so adverse that such development should be precluded. This Nation's experience with relying on imported oil has already demonstrated the need for considering the economic and political implications of energy decisions, whereas on a net energy basis importing oil is extremely attractive.

Opponents' views

Those who are opposed to net energy analysis generally believe that this analytic tool is not needed. They contend that existing tools of analysis are sufficient for purposes of planning and establishing priorities for this Nation's energy needs. Opponents believe the lack of a constant unit of measure for economic analyses is of little or no consequence because the problem can be mitigated by applying discounting techniques in their studies.

Opponents also point to the state-of-the-art problems associated with net energy analysis and claim that such problems will never be completely overcome. In addition, they contend that economic analysis is more comprehensive than net energy analysis because the dollar accounts for a wider variety of interacting forces than does a unit of energy.

ERDA'S EFFORTS TO OVERCOME THE PROBLEMS ASSOCIATED WITH NET ENERGY ANALYSIS

Although about 2-1/2 years have passed since ERDA was charged with the responsibility for considering the net energy yields of competing energy technologies, the problems inhibiting the effective development and use of the net energy concept remain essentially unresolved. Efforts to resolve these problems have been slow and piecemeal. In addition, ERDA has no overall plan with performance objectives, milestones, and target dates for use by management to ensure the timely development and use of net energy analysis.

Following enactment of the Federal Nonnuclear Energy Research and Development Act of 1974, ERDA's efforts largely centered on supporting studies of the net energy yields of various technologies. For example, net energy calculations for fossil and electric energy systems were performed by Development Sciences, Inc., under a contract initially with the Department of the Interior but completed under the sponsorship of ERDA's Office of Planning and Analysis. The calculations covered nine fossil energy systems and seven basic electric energy producing systems using fossil fuels and nuclear, geothermal, and solar resources. The results of these studies have often been at variance with studies prepared by universities, industry, and research institutions and, in some cases, the variances have been great.

According to Planning and Analysis officials their strategy is to complete enough net energy analyses of various technologies to help them address and resolve the problems, establish standards for making such analyses, and provide guidelines to ERDA program divisions in applying net energy analysis to their respective technologies.

Although Planning and Analysis has been supporting studies which specifically address the problems confronting the development and use of net energy analysis, as of early May 1977, several of the studies were still incomplete. For example, the Institute for Energy Analysis has been making a review, under a contract with ERDA, to identify the advantages and disadvantages of alternative measures of energy input and output, to determine the most appropriate definitions of net energy for policy decision purposes, and to develop a consistent net energy approach to be applied to all pertinent energy technologies. This review was initiated in July 1975 and ERDA anticipates that it will not be completed before the end of fiscal year 1977.

Planning and Analysis officials said that this contractor is also assisting them in preparing guidelines for making net energy analyses and that they plan to issue these to the various program divisions. The guidelines should help the divisions in selecting appropriate boundaries, data bases, and approaches for making such analyses. As of early May 1977, however, these guidelines were still incomplete.

Planning and Analysis also awarded a contract in March 1976 to the Center for Advanced Computation at the University of Illinois to improve the data on indirect energy costs and to develop a methodology for combining the process analysis and input-output analysis approaches into ERDA's hybrid approach to net energy analysis. This work is scheduled to be completed by the end of fiscal year 1977.

Although ERDA has supported some studies on the process analysis and input-output approaches, it has not made an in-depth evaluation of the eco-energetics approach. Studies based on the eco-energetics approach usually have results which vary widely from results based on studies using process or input-output analysis. This has led to considerable controversy among net energy researchers and practitioners concerning the relative merits of the approach.

Planning and Analysis officials had hoped to fund some studies of the eco-energetics approach in fiscal year 1976 but were precluded from doing so by budget limitations. They are now planning to support one study later this year and expect the effort to carry over into fiscal year 1978.

In addition to the studies funded by ERDA's Office of Planning and Analysis, some of the program divisions were supporting studies relating to the development and use of net energy analysis. For example, the Division of Geothermal Energy is examining the potential usefulness of this analytical tool and the methods for performing the associated studies. In addition, the Division of Solar Energy had a study underway which examined the state of the art and various methodologies for performing net energy studies. This work was initiated in October 1976 by ERDA's Pacific Northwest Laboratories and was expected to be completed in fiscal year 1977. However, solar energy officials advised us that they were not satisfied with the contractor's performance and the contract was terminated in July 1977.

CONCLUSIONS

The Federal Nonnuclear Energy Research and Development Act of 1974 requires ERDA to analyze and consider potential

net energy production in planning and carrying out its RD&D programs. Although ERDA has supported a number of studies involving net energy analyses, it has made only minimal use of the results.

We recognize that net energy analysis is a relatively new concept and involves major state-of-the-art and other problems. Because of these problems, some of the studies have shown widely different net energy yields for a given technology. These widely varying results tend to discredit net energy analysis and may impede its further development into a useful tool for energy planning and priority setting. Already, considerable controversy exists among energy policy and decision makers in Government, industry, and academia concerning the potential usefulness of the net energy concept.

ERDA should take a more aggressive and responsive approach to resolving the issues involved. Although some of ERDA's ongoing studies address certain problems, they give only slow and piecemeal treatment to the problems and are not part of an overall plan.

ERDA should develop a formal, comprehensive management plan for supporting activities to resolve the various problems inhibiting the development and use of net energy analysis. A plan is needed to ensure that all aspects and problems associated with the net energy concept are thoroughly studied in the shortest possible time. This plan should include milestones and target dates against which progress can be measured in carrying out the plan. ERDA should also develop plans and procedures, as appropriate, to apply net energy analysis in planning and carrying out this Nation's energy RD&D.

Also, we believe the status and results of ERDA's efforts in developing and using net energy analysis should be reported periodically to the Congress. This could be useful to the Congress in evaluating the progress and problems relative to carrying out the requirements of the Federal Nonnuclear Energy Research and Development Act of 1974 and in making more informed decisions on national energy matters.

RECOMMENDATIONS

We recommend that the Administrator, ERDA:

--Develop a formal, comprehensive management plan, including objectives, milestones, and target dates for timely resolution of the problems associated with net energy analysis.

--Develop procedures for implementing the plan and decision points for evaluating progress. One of the decision points should be a complete assessment of the potential usefulness of net energy analysis, including the extent to which it can be used as a reliable energy policy and decision making tool

--Aggressively implement the plan and annually report to the Congress on the status and results of these efforts as part of the annual authorization and appropriation process.

--Develop plans and procedures to use net energy analysis to the extent practical in planning and carrying out energy RD&D.