BY THE U.S. GENERAL ACCOUNTING OFFICE

# Report To The Chairman, Subcommittee On Energy Conservation And Power Committee On Energy And Commerce House Of Representatives

# Status Of Various Electric Energy Conservation Programs, Activities, And Powerplant Capacities In The United States

The Chairman of the Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, asked GAO to answer five specific questions on the status of electric energy-related efficiency activities in the United States.

This report provides information on the status of Federal, State, and utility energy-efficiency improvement programs. It also highlights the status and performance trends of domestic electricity-producing powerplants.





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WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

B-206928

The Honorable Richard L. Ottinger
Chairman, Subcommittee on Energy
Conservation and Power
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

In response to your December 2, 1982, request, we are providing the results of our examination of the status of electric energy-related efficiency improvement programs, and other electric-related activities, nationwide. This report is one of three you requested. The other two deal with (1) the financial health of the electric industry and (2) electric utility demand forecasting and are being provided under separate cover. In this report, you specifically asked us to provide data on

--the status of implementation of federally funded conservation programs by the Federal Government, States, and regulated and unregulated electric utilities (see app. II);

--the number and kinds of conservation programs that are funded solely by States or utilities which are designed to encourage improvements in the efficiency of electricity consumption (see app. III);

--the use of marginal or incremental cost methods to calculate retail electric rates (see app. IV);

--the status of the electric energy services industry and related industries that can determine the need for, and subsequently install, energy efficiency improvements (see app. V); and

--the status of existing powerplant productivity in terms of capacity factors and other relevant measures of efficiency of electricity production (see app. VI).

Details addressing each of these five issues are presented in separate appendixes as indicated. Our approach to address these issues is discussed in appendix I.

## STATUS OF FEDERAL CONSERVATION PROGRAMS

Federal energy conservation programs are in various stages of implementation. Of the 14 programs included in our review, 6 are fully implemented; 6 are not fully implemented, but efforts are underway to achieve full program implementation; and the status of 2 programs could not be determined. The following table shows the status of the 14 programs.

Status of 14 Federal Conservation Programs

| Program | Fully implemented | Not fully implemented | Undetermined |
|---|---|---|---|
| Energy Extension Service | X | | |
| State Energy Conservation Program | X | | |
| Low Income Weatherization | X | | |
| Low Income Energy Assistance (weatherization portion) | X | | |
| Schools and Hospitals Program | X | | |
| Appliance Efficiency Standards | X | | |
| Appliance Labeling | | X | |
| Building Energy Performance Standards | | X | |
| Residential Conservation Service | | X | |
| Commercial and Apartment Conservation Service | | X | |
| Solar Energy and Energy Conservation Bank | | X | |
| Industrial Energy Conservation | | X | |
| Residential Energy Efficiency | | | X |
| Federal Energy Management | | | X |

The Industrial Energy Conservation Program involves long-term generic research by industrial companies or other private institutions operating under cost-shared contracts or cooperatives with the Department of Energy (DOE). This program has not yet been fully implemented because of its long-term focus of activities. The Residential Energy Efficiency Program has not been targeted for funding by DOE, and the Federal Energy Management Program is too complex for us to evaluate in the time permitted because of its many program requirements.

The contribution of Federal programs to improving the efficiency of the Nation's electrical energy use is uncertain. Three major reasons for this situation are that (1) the impact of most Federal programs depends on voluntary consumer response, (2) actions taken by consumers as a result of the programs will affect a number of energy sources, and (3) full program implementation has not been achieved for many of the programs. (See app. II.)

## STATUS OF STATE AND UTILITY CONSERVATION PROGRAMS

### State programs

State-funded energy conservation programs exist in 14 of the 43 States which responded to a questionnaire we developed to determine the number of States fostering conservation efforts. Some of the State-funded conservation programs, however, appear to be similar to federally funded programs. Of the 14 States reporting that they fund conservation programs, 8 provide one or more of the following kinds of conservation efforts: install insulation to reduce heat or air-conditioning losses; permit utilities to develop rates and other measures to reduce demand for energy; require individual electric metering and billing as opposed to single metering and billing for multiple-user systems; and audit buildings' energy use to determine ways of reducing that energy usage.

### Utility programs

We were unable to determine the number of conservation programs funded solely by utilities. However, we were able to determine that utility-fostered conservation programs are State sanctioned and appear related to federally mandated conservation programs. Of the utilities that we have data for, almost 47 percent foster a conservation measure similar to those encouraged by the Federal Residential Conservation Service (RCS). (RCS is discussed in app. II.) For example, the kinds of programs most often promoted by utilities are (1) energy audits of buildings to determine ways of reducing energy use, (2) financial assistance such as low- or no-cost loans to encourage installation of energy-saving devices, and (3) providing energy-saving materials at low or no cost.

Responses from State commissioners to a National Association of Regulatory Utility Commissioners' (NARUC's) recent inquiry addressing the same subject yielded results similar to those received by us from our questionnaire. In effect, the NARUC survey confirmed that most State conservation program efforts appear to be related to some Federal initiative, and States rely on the utilities to implement most conservation measures. However, even when State or utility conservation efforts are identified, it is difficult to measure (quantify) the effect of the program in terms of reducing energy use because utilities do not monitor program results. (See app. III.)

## USE OF MARGINAL OR INCREMENTAL COST METHODS

Different responses to our and NARUC's questionnaires indicated inconsistencies over meaning and use of marginal and incremental cost methods. Simply defined, marginal or

incremental costs are the changes in total costs associated with a unit change in the quantity of supply. Since this costing method results in higher rates to customers with increased demand, ratemaking based on marginal or incremental cost methods is a mechanism considered useful in fostering conservation because higher rates tend to reduce consumer demand.

Few States (13 of 43 responding to our questionnaire) said they use marginal or incremental cost methods to formulate rates. The amount of electricity sold within those States using a marginal or incremental cost method varies from 0.001 percent of total sales to 100 percent of sales.[1]

We collected the results of a recent NARUC questionnaire to compare them with our findings. Based on our and NARUC's questionnaires, no regional trends in the use of marginal or incremental costs are apparent. (See app. IV.)

## STATUS OF THE ENERGY SERVICES INDUSTRY

The energy services industry, as defined in our analysis, consists of those entities that are capable of determining the need for and have the ability to install energy efficiency improvements. Financial institutions or other sources of financial aid offering reduced interest rates for the financing of specific energy efficiency improvements are also considered part of the energy services industry.

Rising energy prices brought Federal laws to encourage energy efficiency activities. One law requires States to maintain a master list of qualified businesses capable of evaluating the need for, installating, or financing energy efficiency measures. This Federal requirement is part of the Residential Conservation Service Program which is discussed in appendix II. The RCS Program has several important features which we discuss throughout this report.

Currently, the energy services industry in the 13 States we contacted varies in size, importance, and usefulness. In addition, experts have mixed views concerning the industry's future viability. Even utility and State officials have differing impressions of the industry's cohesiveness and future existence. Most of these mixed views concerning the service industry's status stem from the current state of the economy and whether the industry can survive during the current energy surplus. We

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[1]Some States told us they use marginal or incremental cost methods 100 percent of the time. Marginal or incremental cost methods are restricted in practical application because of revenue limitations and ratesetting practices imposed by regulators.

recognize these conditions can affect, to some extent, the industry's current and future status. In any event, based on our limited review, the energy services industry seems to exist to the extent that it can currently meet customer demands for energy efficiency improvements. (See app. V.)

## STATUS AND PERFORMANCE TRENDS OF ELECTRIC POWERPLANTS

The final question asked by the chairman concerns electric powerplant capacities and trends. As of December 31, 1981, the Nation's utilities had a powerplant inventory of 10,772 units--powerplants often consist of more than one generating unit--with a total nameplate[2] capacity of 640,888 megawatts (MWs). These units are categorized by their fuel source and total net generation in the following table.

Powerplant Units by Fuel Source and Generation
December 31, 1981

| Number of units | Fuel source | Net generation in gigawatthours[a] | Percentage of generation |
|---|---|---|---|
| | | (000 omitted) | |
| 1,332 | Coal | 1,203.2 | 52 |
| 4,396 | Oil | 206.0 | 9 |
| 1,639 | Gas | 345.8 | 15 |
| 3,276 | Water | 260.7 | 11 |
| 78 | Nuclear | 272.7 | 12 |
| 51 | Others | 6.4 | - |
| 10,772 | | 2,294.8 | 100[b] |

[a]A gigawatthour is equal to one billion watthours, one million kilowatthours, or one thousand megawatthours of electricity.

[b]Percentage total does not equal 100 due to rounding.

Total dependable capacity for electricity in the summer of 1982 was estimated by DOE at about 583,000 MWs with peak demand of about 441,000 MWs. The difference between capacity and peak

[2]Nameplate capacity is the full-load (maximum) continuous rating of a generator under specified conditions as designated by the manufacturer. We will use nameplate capacity in this discussion of existing capacity because DOE regional and fuel data were consistently available on a nameplate capacity basis. Later, in discussing powerplant performance trends, we will use maximum dependable capacity (which is somewhat lower than nameplate capacity) because it is the more appropriate measurement of capacity in relation to performance.

demand left a 32 percent reserve margin. Since 1970, reserve margins have increased from about 20 percent to the approximate 32 percent determined for 1982. This increased reserve margin resulted when additions to generating capacity increased at a faster rate than peak demand.

While there is no single, comprehensive measure of powerplant performance, indications are that the performance of the Nation's powerplants is declining. From 1970 to 1981, the average powerplant capacity factors--generation as a percentage of a powerplant's maximum dependable capacity over a specified period in time--declined from 67.8 to 63.4 percent for routinely used plants and from 55.3 to 45.4 percent for plants used only when additional electricity is needed. Most of the decline is due to an increased amount of capacity with no corresponding increase in demand. This means some capacity is not used as much since it is not needed.

Two other measurements used to determine powerplant performance are (1) operating availability factor (AF) and (2) equivalent availability factor (EAF). The AF is the percentage of time a unit can generate electricity if it could operate continually without interruptions (outages). The EAF, however, factors in the effect of forced and scheduled outages. Therefore, the EAF is the equivalent percentage of time a unit is available for operation at full capability. Both of these measures indicate a downward trend in powerplant performance. In addition, some independent studies of certain classes of powerplants also indicate that performance is declining but point out that utilities can take actions to mitigate declining performance. (See app. VI.)

## AGENCY COMMENTS

Formal comments on a draft of this report were provided to us during a meeting with staff of the Assistant Secretary, Conservation and Renewable Energy, and other departmental officials. The Department's overall thrust in commenting on this report's contents focused on updating several energy conservation programs' status. Other comments were provided and, where appropriate, incorporated.

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At your request, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of the report. At that time we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

J. Dexter Peach
Director

# Contents

## ABBREVIATIONS

| | |
|---|---|
| AF | availability factor |
| Btu | British thermal unit |
| DOE | Department of Energy |
| EAF | equivalent availability factor |
| EIA | Energy Information Administration |
| EPRI | Electric Power Research Institute |

| | |
|---|---|
| FTC | Federal Trade Commission |
| GAO | General Accounting Office |
| GW | gigawatt |
| GWH | gigawatthour |
| HUD | Department of Housing and Urban Development |
| KW | kilowatt |
| KWH | kilowatthour |
| MW | megawatt |
| MWH | megawatthour |
| NARUC | National Association of Regulatory Utility Commissioners |
| NERC | North American Electric Reliability Council |
| NGA | National Governor's Association |
| RCS | Residential Conservation Service |
| TVA | Tennessee Valley Authority |

## OBJECTIVES, SCOPE, AND METHODOLOGY

In his letter dated December 2, 1982, the Chairman of the Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, asked us to answer five specific questions on various aspects of Federal electric energy conservation-related programs and activities. We were also asked to note any regional trends in the use or adoption of a specific conservation-related program or activity.

In meetings with the chairman's office, we agreed to provide relevant data and update those data to the extent possible. Wherever possible, we relied on our prior work and other data already developed and available. To obtain data not available elsewhere, we sent a brief questionnaire to public utility commissioners in the 50 States and the District of Columbia. With one exception (see p. 2), data we identified as relevant to our efforts were obtained.

We conducted our review primarily in the Washington, D.C., area by contacting officials of the National Association of Regulatory Utility Commissioners, the Edison Electric Institute, the Electric Power Research Institute, the National Governors Association, and various offices of the Department of Energy (DOE). At each location, we interviewed responsible officials knowledgeable of the electric industry. Except as noted below, we performed our review in accordance with generally accepted government auditing standards.

The following sections describe the steps we took to answer each question.

### WHAT IS THE STATUS OF IMPLEMENTATION OF FEDERAL CONSERVATION PROGRAMS BY THE GOVERNMENT, STATES, AND ELECTRIC UTILITIES?

To determine the status of implementation of federally funded conservation programs by the Federal Government, States, and regulated and unregulated electric utilities, we reviewed and relied on, to the extent possible, our past work which we footnote throughout appendix II. To supplement our past work and update the implementation status of the 14 Federal programs specified by the chairman's office, we held discussions with DOE officials in Washington, D.C., responsible for implementing the programs. We also reviewed and collected copies of pertinent agency records, reports, program rules and regulations, and authorizing legislation. However, we did not independently verify information obtained on any program's status from DOE officials because of the number of programs reviewed and the time frame in which we performed our review. (See app. II.)

## HOW WIDESPREAD ARE OTHER STATE AND UTILITY PROGRAMS DESIGNED TO ENCOURAGE IMPROVEMENTS IN THE EFFICIENCY OF ELECTRICITY CONSUMPTION?

In obtaining information on the number and kinds of State or utility conservation programs being conducted, we used data from existing studies whenever possible and supplemented existing data with responses from our questionnaire. On this topic, we asked State public utility commissioners, "What conservation programs are funded solely by the State?" Some responses resulted in data on utilities' programs because some States which do not have any conservation programs furnished data on their utilities which do have such programs. We used a questionnaire because available data on State-funded programs were not adequate.

In order to determine the existence of any regional trends or adoption of a specific conservation program, we divided the United States into seven regions composed of groups of contiguous States--except, obviously, Alaska and Hawaii which were included in the Northwestern and Western regions, respectively (see the regional map on p. 23). We based the regions on State groupings for simplicity and ease of use. Within the regional groupings, we looked for similarities among programs and activities that might indicate a trend.

In addition to our questionnaire, we contacted officials at DOE, the National Association of Regulatory Utility Commissioners, the Edison Electric Institute, the Electric Power Research Institute, and the National Governors Association (NGA) in the Washington, D.C., area. Data from these entities were made available to us in all cases but one. NGA, which had recently received the responses to a questionnaire, was unwilling to make its questionnaire results available to us. NGA had asked each State's public utility commission and energy office questions concerning conservation programs--the kinds of data we believed germane to our effort. NGA expects to finalize its survey results in a report later this year, according to an NGA official. At the various other entities we obtained copies of documents and correspondence pertaining to State-funded and utility-funded conservation programs which were developed and published by the various entities. However, time constraints did not permit us to independently verify any of these data.

Finally, we reviewed industry published articles that discuss current actions being taken by some major electric utility companies that find themselves with surplus electric energy. (See app. III for detailed discussion of this topic.)

## HOW WIDESPREAD IS THE IMPLEMENTATION OF RETAIL ELECTRIC RATE STRUCTURES THAT USE MARGINAL OR INCREMENTAL COST METHODS?

To obtain information on the use of marginal or incremental costs within State boundaries, we included in our questionnaire

the question, "Did any utilities under your jurisdiction use retail rate structures based on marginal or incremental costs?" We did not provide a definition of marginal or incremental costs because, as the chairman's office requested, the respondents were to use their own judgment and understanding of these terms when providing data.

The portion of our questionnaire addressing the use of marginal or incremental cost methods was designed only to provide an inventory or status of those States in which utilities are using marginal or incremental cost methods. The questionniare did not allow for detailed descriptions of the types of marginal or incremental cost methods used; therefore, we followed up on responses that appeared questionable or inconsistent with prior data. In displaying data, we provide only the number of States which indicated that some utilities use marginal or incremental cost methods.

To determine if any regional trends exist in the use of a marginal or incremental cost method, we used the same regional design--seven regions composed of groups of States--as that used to determine regional trends for State and utility use of conservation programs. (See app. IV for detailed discussion of this topic.)

WHAT IS THE STATUS OF DEVELOPMENT OF THE ENERGY SERVICES INDUSTRY TO MEET DEMAND FOR CUSTOMER EFFICIENCY IMPROVEMENT MEASURES?

Our first step was to define the "energy services industry"--what kinds of businesses are involved and what services they perform. We spoke to several officials of associations, industry experts, and State officials with knowledge of what might constitute the energy services industry. These contacts shared their knowledge and provided a variety of material on the industry's structure, markets served, means of advertising, qualification requirements, regional differences in type of service performed, and relationship with Federal programs.

Since part of this objective was to provide a regional perspective, we contacted 13 State officials (approximately two from each of the seven regions we devised) to obtain an indication of what the level of activity in the service industry was on a regional basis. The 13 States contacted were Arkansas, Colorado, California, Illinois, Maine, Mississippi, New York, Ohio, Oregon, South Carolina, Tennessee, Texas, and Washington. We also decided to present our data by using five categories for display purposes: (1) market potentials, (2) entry into the industry, (3) public knowledge of the industry, (4) external influences on the industry, and (5) current status of the industry. (See app. V for detailed discussion of this topic.)

## WHAT IS THE STATUS AND TREND OF U.S. POWERPLANT PRODUCTIVITY IN TERMS OF CAPACITY FACTORS AND OTHER MEASURES OF EFFICIENT ELECTRICITY PRODUCTION?

To assess powerplant productivity trends, we relied heavily on DOE and industry data. We obtained data on the number of powerplants, generating capacities, fuels used for generation, and regional locations of powerplants primarily from two sources: DOE and the North American Electric Reliability Council. We gathered data on powerplants operating between 1950 and 1982. We present the data on powerplants in two parts--first, the status of existing powerplants and, second, the trends in powerplant performance. For data on powerplant trends, we provide performance data for a 12-year time frame, 1970 through 1982. However, because of our limited time frame, we were unable to independently verify any of the data. In addition, the 1970 through 1982 time frame was used because of several events--the Arab oil embargo, the state of our economy, and energy surpluses--which have affected electricity production.

## IMPLEMENTATION STATUS OF

## FEDERAL CONSERVATION PROGRAMS

Energy conservation, simply put, is using energy more efficiently and reducing energy waste, thus reducing national energy needs. It is generally accepted that reducing energy needs is less costly than purchasing new energy supplies. Several Federal laws play a major role in developing conservation efforts. Initial guidance concerning energy conservation comes from such laws as:

--The Energy Policy and Conservation Act (Public Law 94-163, Dec. 22, 1975), which sets efficiency targets for appliances.

--The Energy Conservation and Production Act (Public Law 94-385, Aug. 14, 1976), which authorizes the development of energy efficiency standards for buildings and weatherization assistance for low-income persons.

--The National Energy Conservation Policy Act (Public Law 95-619, Nov. 9, 1978), which establishes the Residential Conservation Service Program to be implemented by States and utilities, and requires consideration of energy efficiency standards for appliances.

The programs stemming from the passage, and subsequent amendments, of these and other laws are intended to focus on the private sector, consumers, State governments and, through the Federal Energy Management Program, the Federal Government. Most of the Federal responsibility to carry out mandated programs is placed with the Department of Energy.

This appendix provides information on the status of the implementation of 14 specific Federal energy conservation programs.[1]

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[1]The programs include: Appliance Efficiency Standards; Appliance Labeling; Building Energy Performance Standards; Energy Extension Service; Federal Energy Management Program; Residential Conservation Service; Commercial and Apartment Conservation Service; Low-Income Weatherization; Low-Income Energy Assistance (weatherization portion); Schools and Hospitals Program; State Energy Conservation Program; Solar Energy and Energy Conservation Bank; and Residential Energy Efficiency Program.

## APPLIANCE ENERGY EFFICIENCY STANDARDS AND APPLIANCE ENERGY LABELS

The Energy Policy and Conservation Act passed in 1975, as amended by the National Energy Conservation Policy Act passed in 1978 (Public Law 95-619), directs the Secretary of Energy to prescribe an energy efficiency standard for each of 13 major household appliances.[2] No standard is to be prescribed which would not (1) be economically justified, (2) be technologically feasible, or (3) result in significant conservation of energy. DOE in developing the standards is directed to consider their impact on, among other things, manufacturers, consumers, life-cycle costs, appliance usefulness, and national energy conservation.

The Appliance Energy Efficiency Standards Program is fully implemented. On April 2, 1982, DOE published, for public comment, a proposed appliance standard rule covering 8 of the 13 appliances.[3] This proposal contained DOE's determination that for those eight products a standard would not result in any significant conservation of energy or be economically justified. On December 22, 1982, DOE issued a final rule establishing a "no standard" for two appliances: clothes dryers and kitchen ranges/ovens. At that time, DOE stated it was continuing the rulemaking process for six additional appliances based on public comments received on its April 1982 proposal. On August 25, 1983, DOE issued a final rule for these six products which established "no standard" for each. Given DOE's final rules this program will have no impact on improving electrical energy use efficiency.

In addition to the energy efficiency standards, the act also requires that the same 13 major household appliances bear an

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[2]The 13 appliances include:

| | |
|---|---|
| Furnaces | Clothes dryers |
| Water heaters | Freezers |
| Home heating equipment other than furnaces | Room air conditioners |
| | Dishwashers |
| Central air conditioners | Humidifiers/dehumidifiers |
| Refrigerators | Clothes washers |
| Ranges/ovens | Television sets |

[3]The eight appliances, which were given priority by the Congress, include:

| | |
|---|---|
| Furnaces | Ranges/ovens |
| Water heaters | Clothes dryers |
| Central air conditioners | Freezers |
| Refrigerators | Room air conditioners |

energy label disclosing pertinent information about the appliances' energy efficiency and/or energy cost of operation. The appliance labeling requirement is administered by the Federal Trade Commission (FTC).

The appliance labeling program is not fully implemented. FTC published labeling rules for 7 of the 13 covered products[4] and has exempted 5 appliances from the labeling requirement based on its determination that labels for the 5 products would not be effective in furthering the purposes of the program. A final labeling rule for central air conditioners (including heat pumps) is still under development. In addition, FTC is also developing a labeling rule for a new, technologically advanced furnace to supplement its existing furnace labeling rules.

To what extent the appliance labeling program has or will cut down on electrical energy use is unclear. In a previous report[5] we commented on the potential for the labeling program to increase consumers' awareness of the energy efficiency of appliances they purchase. Our work indicated that for furnaces, the largest single user of residential energy, appliance labeling was not likely to significantly affect consumer purchase decisions because customers did not usually ask about furnace efficiencies and dealers did not usually provide that information. Since the labeling program does not directly affect electrical energy use, and only potentially affects consumer purchase decisions, the program's ultimate impact on electrical use is uncertain.

RESIDENTIAL CONSERVATION SERVICE

The National Energy Conservation Policy Act (Public Law 95-619), as amended by the Energy Security Act passed in 1980 (Public Law 96-294), established the Residential Conservation Service (RCS) Program which requires large electric and gas utilities to provide various energy conservation services--primarily energy audits--to their residential customers. A number of ancillary services are also provided to help implement recommended measures. These services include (1) identifying State-approved installers, suppliers, and lenders that can assist consumers in undertaking suggested conservation measures, (2) arranging for the installation or financing of suggested conservation measures, (3) inspecting completed conservation measures in certain instances, and (4) providing conciliation services for consumer complaints.

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[4]The seven appliances include refrigerators, freezers, dishwashers, water heaters, room air conditioners, clothes washers, and furnaces.

[5]"Appliance Efficiency Standards: Issues Needing Resolution by DOE" (GAO/EMD-82-78, May 14, 1982).

RCS has not been fully implemented by DOE. According to DOE, as of late August, 14 States did not have approved program plans covering utilities in their States, although plan approval for 5 of these States is pending. In addition, DOE believes that in another 5 States, which had approved plans as of December 1982, utilities were not adequately implementing those plans as provided for in DOE program regulations.

We discussed the fact that DOE has not achieved full implementation of RCS in a prior report.[6] We found that a wide diversity existed in the operational status of State programs and that States were uncertain about the program's future. We concluded that DOE's nonfulfillment of its administrative and enforcement responsibilities significantly contributed to a situation where half of the States either did not have an RCS Program or were not implementing the program consistent with existing regulations or approved State plans.

The RCS Program contributes to improving the efficiency of the Nation's electric energy primarily by providing on-site energy audits of consumers' homes. The energy auditor identifies specific energy conservation opportunities and determines the costs and expected energy savings associated with installing appropriate conservation measures. This information is provided to the consumer who decides which conservation measures, if any, he or she wants to install. Any actions taken by consumers based on the RCS energy audit would primarily conserve the type of energy used for heating because, for most households, heating is the largest component of the energy bill. About 17.5 percent of all housing units in the Nation use electricity as their primary heating source.

## COMMERCIAL AND APARTMENT CONSERVATION SERVICE

Another Federal program established by the National Energy Conservation Policy Act, as amended by the Energy Security Act, is the Commercial and Apartment Conservation Service (Commercial and Apartment Program), a program similar to RCS, which provides energy audits to owners or tenants of small commercial buildings or owners of multifamily dwellings.

The Commercial and Apartment Program has not been fully implemented by DOE. Proposed rules to carry out the program were initially published in January 1981. However, the new administration withdrew them and did not issue new proposed rules until November 24, 1982. As of March 1983, DOE was considering the public comments received on the proposed rules. Final rules for this program, however, had not been issued by late August 1983.

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[6]"The Residential Conservation Service: Issues Affecting the Program's Future" (EMD-82-70, Mar. 29, 1982).

Under the program, the majority of commercial and apartment buildings in the Nation could receive energy audits. According to DOE's Preliminary Regulatory Impact Analysis of the Commercial and Apartment Program, about 64 percent of commercial building stock and 66 percent of apartment buildings will be eligible to obtain the energy audit. However, this analysis also stated that the commercial buildings eligible for the program consume only about 10 percent of the energy consumed by all commercial buildings. The analysis did not provide a comparable estimate for apartment buildings.

We did not independently assess the program's potential impact on improving electrical energy use efficiency. However, based on its preliminary assessment of overall Commercial and Apartment Program impact, DOE estimated the total energy savings to be about 15 trillion Btu's per year, or the equivalent of about 7,500 barrels of oil per day.

## BUILDING ENERGY PERFORMANCE STANDARDS

The Energy Conservation and Production Act passed in 1976 (Public Law 94-385) directs DOE to develop and promulgate building energy performance standards (Building Standards) for new buildings. The standards are to achieve the maximum practical level of energy savings through energy-efficient building design. The Housing and Community Development Act of 1980 (Public Law 96-399) required DOE to issue interim standards in August 1981 and final standards in April 1983. However, the Omnibus Budget Reconciliation Act of 1981 (Public Law 97-35) directed that Building Standards become voluntary performance standards, except in the case of Federal buildings, which would be guidelines for the purpose of providing technical assistance for the design and construction of energy-efficient buildings. The law also set April 1, 1984, as the effective date for standards.

DOE has not yet published voluntary Building Standards guidelines for the private sector or established standards for Federal buildings because guidelines are still being developed. According to a DOE program manager in the Building Systems Division, DOE published draft Building Standards guidelines for private-sector use in constructing manufactured homes on May 9, 1983. These are to be followed in September with similar guidance on the design and construction of five residential building prototypes. Guidance on commercial buildings is scheduled for mid-October. With respect to mandatory standards for Federal buildings, the DOE officials told us that DOE's current plans call for a proposed rulemaking early in 1984 addressing standards for residential structures. No timetable is set for proposing commercial buildings standards applicable to Federal buildings.

## STATE ENERGY CONSERVATION PROGRAM AND THE ENERGY EXTENSION SERVICE

The State Energy Conservation Program is authorized by the Energy Policy and Conservation Act, as amended by the Energy Conservation and Production Act. The purpose of the program is to promote energy conservation and reduce the growth rate of energy demand in both the public and private sectors. Under the program, administered by DOE, grants are provided to States to assist them in carrying out State-developed energy conservation policy plans and programs. Originally authorized for fiscal years 1976 through 1979, the program was continued and grant funds have been provided for fiscal years 1980-83.

The National Energy Extension Service Act (42 U.S.C. 7001) established the Energy Extension Service as a program to develop and implement a comprehensive effort for the identification, development, and practical demonstration to small scale-energy users of energy conservation practices and measures as well as the use of renewables. As part of this effort, Federal funds were made available to support State-developed Energy Extension Service Programs. Pursuant to the Omnibus Budget Reconciliation Act of 1981, States are required to provide at least a 20-percent cost share from non-Federal funds. This DOE-administered program has provided grant funds to States since fiscal year 1980.

Both the State Energy Conservation and the Energy Extension Service Programs are fully implemented. Funds made available for these programs, including fiscal year 1983 appropriations, total about $410 million, including about $313 million for the State program and about $97 million for the Extension Service Program. The funds have been used by the States to support numerous State-developed energy conservation programs and projects, such as information dissemination, van-pooling, telephone hot-lines providing energy information, and consumer energy workshops.

The impact of both programs on improving electrical energy use efficiency is difficult to determine because neither focuses specifically on conserving electrical energy. We have, however, reported on the programs' overall energy savings impact. With respect to the State program, we reported in April 1982[7] that the six States covered in our review undertook a large number of programs that accounted for minimal projected energy savings but a major share of the State Energy Conservation Program funds; carried out programs in the residential energy conservation area which were of questionable effectiveness; and were overly optimistic about or did not know the energy savings impact of programs being carried out.

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[7]"State Energy Conservation Program Needs Reassessing" (EMD-82-39, Apr. 21, 1982).

Concerning the Energy Extension Service, we reported in February 1981[8] that State Energy Extension Service Program activities, to a large degree, simply continued information dissemination activities previously funded by the State Energy Conservation Program or duplicated energy conservation information activities, such as energy conservation brochures, being carried out in the private sector. We concluded in our previous report that the effectiveness of many of these activities in encouraging consumers to undertake energy conservation actions was limited.

## FEDERAL ENERGY MANAGEMENT PROGRAM

The Federal Government is the largest single energy user in the Nation, accounting for about 2.4 percent of total U.S. energy consumption. To reduce the Government's energy use, several congressional and executive mandates have been established. Section 301 of the Energy Policy and Conservation Act calls for the development of a 10-year plan for energy conservation in Federal buildings as well as other actions to reduce the Government's energy use. The scope and specificity of the 10-year buildings plan, which is the overall framework for improving energy use efficiency in Federal buildings, were broadened by Executive Order 12003, signed in July 1977, and by the National Energy Conservation Policy Act. In addition, other requirements have been placed on Federal agencies to reduce energy use overall, not just for buildings. Generally, these activities are collectively called the Federal Energy Management Program. A program office of the same name is administered by DOE and is responsible for overseeing and monitoring the progress of Federal agencies in reducing their energy use.

Elements of the 10-year plan, as originally mandated, included establishing mandatory lighting and thermal standards and insulation requirements for Federal buildings and plans for replacing or retrofitting buildings to meet such standards. Executive Order 12003 further defined the 10-year plan requirements by setting energy consumption reduction goals of 20 percent for existing Federal buildings and 45 percent for new Federal buildings, both to be achieved by 1985. The National Energy Conservation Policy Act called for establishing energy performance targets for Federal buildings and required that actions be taken to achieve such targets. This act also required Federal agencies to conduct energy audits of all Federal buildings under their control and undertake appropriate retrofit measures. With respect to new Federal buildings, the Energy Conservation Standards for New Buildings Act of 1976 (Public Law 94-385, as amended) requires that such buildings meet the energy performance standards developed under the Building Energy Performance Standards Program previously discussed.

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[8]"Residential Energy Conservation Outreach Activities--A New Federal Approach Needed" (EMD-81-8, Feb. 11, 1981).

Progress has been made in reducing Federal energy use. At the end of fiscal year 1982, based on preliminary Federal energy use information, the Federal Government had achieved a 2 percent reduction in overall energy use from 1975 levels. With respect to energy used in all Federal buildings, the energy use reduction was about 9.4 percent of gross consumption. Concerning the 20 percent reduction goal for existing buildings called for in Executive Order 12003, at the end of fiscal year 1981 (the most recent data available) Federal agencies had achieved a 14.2 percent reduction compared to 1975's use as measured by consumption per gross square foot of building space.

With respect to the numerous requirements which are established for Federal agencies, we pointed out in congressional testimony in October 1981 instances where progress in meeting these requirements had been slow. Most notable of these instances are delays in developing and approving the overall 10-year buildings plan. However, the plan is expected to be approved in the near future. Without further analysis, we cannot determine to what extent all of the requirements are being fulfilled.

The Federal Energy Management Program's impact on improving the efficiency of the Government's electrical energy use is undeterminable. This is due to the program's unspecified source of energy reduction. The program does not limit energy use reductions just to electricity. Its activities are directed at reducing overall energy use with emphasis on petroleum-based fuels. However, electricity use comprises over 50 percent of energy consumed in Federal buildings, which are the primary focus of the major requirements under the energy management program. Thus, it would appear that the program could be expected to improve the Government's electrical energy use efficiency since electricity offers the greatest potential for energy use reductions.

## SOLAR ENERGY AND ENERGY CONSERVATION BANK

The Solar Energy and Energy Conservation Bank was established in the Department of Housing and Urban Development (HUD) by the Energy Security Act. The purpose of the Bank is to encourage energy conservation and the use of solar energy in residences and commercial buildings by providing financial assistance through financial institutions. The financial assistance is for purchasing and installing energy-conserving improvements in residential and commercial buildings and is to be in the form of reducing the principal amount of loans, prepaying interest on such loans, or making grants. Over $30 million is available for the Bank's operations in fiscal year 1983.

The Bank is not fully implemented. In August 1982, HUD published a Notice of Funding Availability and a Notice of Solicitation of Proposals from States. According to the notices, Bank

funds are to be made available to States which develop innovative techniques for interrelating ongoing energy activities with Bank-provided funding. As of March 1983, the Bank had received 53 proposals from States and Territories and had preliminarily approved 51 of these for funding. According to the Bank, cooperative agreements with the States are in the process of being finalized and final program regulations were issued on May 31, 1983. In view of this situation, we have no comments on the Bank's likely impact on improving electrical energy use efficiency.

LOW-INCOME WEATHERIZATION PROGRAMS

Title IV of the Energy Conservation and Production Act authorizes weatherization assistance for low-income persons. DOE was charged with the responsibility for administering the program. Under the program, grants are provided to States, which in turn provide those funds to local governments, Native American tribes, and community action agencies. The funds are primarily used to purchase weatherization materials which are then made available to eligible program recipients for installation in their homes. In addition, the Low-Income Home Energy Assistance Program (Low-Income Program), authorized under Title XXVI of the Omnibus Budget Reconciliation Act of 1981 and administered by the Department of Health and Human Services, provides flexibility for States to use up to 15 percent of funds made available to them under the program for weatherizing low-income households.

The DOE Low-Income Weatherization Program and the low-income weatherization portion of the Low-Income Program are fully implemented. According to DOE, between 1977 and the end of 1982, about 1 million low-income homes were weatherized under its program. Under the Low-Income Program, according to a program official, about 330,000 homes were expected to be weatherized. While we have not reported on the weatherization assistance portion of the Low-Income Program, we stated in an October 1981[9] report that the energy efficiency of the homes served by DOE's program may not have been improved much because of incomplete or inadequate work. Further, we stated that the number of homes that DOE reported as weatherized continued to be overstated. We also expressed concern about the lack of valid data to determine the improvements in energy efficiency achieved in homes that had been weatherized. Accordingly, the report noted that the extent to which DOE's weatherization program is saving electric energy is unclear.

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[9]"Uncertain Quality, Energy Savings, and Future Production Hamper the Weatherization Program" (EMD-82-2, Oct. 26, 1981).

SCHOOLS AND HOSPITALS

The National Energy Conservation Policy Act established a 50-percent matching grant program to assist schools and hospitals in reducing energy use. As created, the program contains two phases. Phase I provided funds to States to conduct statewide surveys to identify eligible institutions and also to conduct energy audits of individual buildings to identify changes to maintenance and operations procedures which could reduce energy use. These identified changes generally had short payback periods--generally under 1 year--and could be accomplished at low or no cost, such as thermostat setback. Phase II of the program includes detailed analyses of costs, savings, and payback periods for various conservation measures for specific buildings and funding for the design, purchase, and installation of specific energy conservation measures identified.

Phase I, surveying schools and hospitals, has been completed and phase II activities are being carried out. Through fiscal year 1982, DOE had awarded about 10,900 grants totaling about $396.5 million for energy conservation projects in over 29,780 buildings. Fiscal year 1983 program funds had not yet been awarded to eligible institutions as of late August 1983.

RESIDENTIAL ENERGY EFFICIENCY PROGRAM

The Residential Energy Efficiency Program was authorized by the Energy Security Act. The purpose of the program is to demonstrate the feasibility of using private sector, profit-making firms or nonprofit organizations to capture wasted energy through systematic retrofit of residential buildings. Such retrofit would be funded from energy savings realized by the utilties serving the residences. The program is administered by DOE and was authorized a total of $10 million.

The program has not been implemented by DOE. In January 1981, DOE issued a notice of proposed rulemaking which defined the program and set forth minimum requirements for submission by State and local governments of proposed Residential Energy Efficiency Program plans. However, in May 1982, DOE issued final program rules which stated that DOE did not intend to fund the program, and that no financial assistance will be made available for a program demonstration unless there is a solicitation by DOE at some future date.

## IMPLEMENTATION STATUS OF STATE AND UTILITY CONSERVATION PROGRAMS

Electric consumption accounts for about 27 percent of national domestic energy demand. Since electricity is a significant energy source, it is important that the United States produce and use it efficiently. Some State and Federal officials view conservation of electricity as a stop-gap measure to deal, in part, with energy crises. Conservation efforts, while once viewed as short-term measures to reduce the adversities of energy shortages, have recently been thought of by some experts as tools in establishing long-range energy policy.

The future of Federal conservation programs is uncertain due to the administration's funding cutbacks. The Federal cutbacks raise the question of how much the States and utilities are willing to spend to take over and foster conservation efforts. While 30 States had established energy offices by 1981, energy functions carried out by State offices since that time have decreased partly because of Federal funding cuts in conservation efforts and changing State priorities. For the near future, an even further reduction in State conservation activity is anticipated in light of energy surplus conditions and continued Federal conservation program cutbacks.

One way for States to encourage conservation efforts, at little or no cost, is by allowing utilities to promote conservation and to incorporate any related expenses into the rate base. While this practice has been allowed, some utilities now find themselves with excess capacities. Surplus capacities that have resulted from (1) overbuilding, (2) adoption of effective conservation measures, or (3) the state of the economy make perpetuating conservation efforts difficult at the present time.

### CURRENT STATE-FUNDED CONSERVATION EFFORTS

In order to provide data on State conservation efforts, we asked the public utility commissioner of each State and the District of Columbia to list the conservation programs under his or her jurisdiction aimed at conserving electricity and funded solely from State funds. We received responses from 43 of the 51 questionnaires sent. Twenty-seven indicated that no conservation programs exist which are solely funded by the State, and two respondents left this question blank. The remaining 14 listed various programs, as shown on the following chart.

APPENDIX III

## Responding States' Conservation Efforts

| STATES | INSULATION & WEATHERIZATION | CONSTRUCTION | RCS | LOAD MANAGEMENT | INFO. PROG. | COGENERATION | MASTER METERING PROHIBITED | RATES | INVEST. PROG. | DEMO. & DEVELOP. | INDUSTRIAL TAX CREDIT | STREET LIGHTING FINANCE | SCHOOLS/HOSP. FINANCE | TAX CREDITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mass. | ● | | | | | | | | | | | | | |
| Ohio | ● | | ● | ● | | ● | | ● | | | | | | |
| Missouri | ● | | | | | | | | | | | | | |
| Oklahoma | ● | | ● | | | | | | | | | | | |
| New Hamp. | | ● | ● | | | | | | | | | | | |
| Nev. | | ● | | | | | | | | | | | | |
| Minn. | | | ● | | | | | | ● | | | | | |
| New York | | | | ● | ● | | | | | | | | | |
| N. Carolina | | | | | | | ● | | | | | | | |
| Wisc. | | | | | | | | | | ● | | | | |
| Colo. | | | | | | | | | | | | | | ● |
| Mont. | | | | | | | | | | | ● | | | |
| Calif. | | | | | | | | | | | | ● | ● | |
| Hawaii | | | | | ● | | | | | | | | | |

Note: The responses reflected in this chart are from the State Commission offices. However, had we solicited responses from State Energy Offices the results, if compared to what we received, would be quite different.

The information provided by the chart shows that only 14 States have fully funded some conservation efforts. Although the data are limited, they indicate that State-funded conservation efforts appear related to Federal initiatives. Further, because our data are limited, we looked to other sources for data on State conservation efforts. As a result, we found that the National Association of Regulatory Utility Commissioners (NARUC) had updated data on the States' conservation policies and activities through December 31, 1981.

APPENDIX III

## NARUC's RECENT STUDY RESULTS ON STATE CONSERVATION PROGRAMS

During 1982, the National Association of Regulatory Utility Commissioners forwarded a survey questionnaire to each State regulatory agency to obtain data on States' conservation policies and activities. The survey, which covered the contiguous 48 States plus Alaska, Hawaii, and the District of Columbia, indicated that at December 31, 1981,

--37 of 51 States (72.5 percent) had adopted conservation policies and

--48 of 51 States (94 percent) had adopted or intend to adopt conservation measures or programs.

The programs that the States had adopted or intended to adopt fall under one of five general categories: insulation, energy audits, solar energy utilization, cogeneration, and load management. These five conservation efforts appear similar to federally mandated efforts. In addition, a sixth conservation category was submitted which primarily includes standards required under the Public Utility Regulatory Policies Act (Public Utility Act).[1]

Since the Public Utility Act requires State regulatory commissions to consider adopting certain ratemaking and regulatory standards, NARUC asked the 51 State commissioners to describe programs which meet these purposes of the Public Utility Act. This question generated 13 responses as follows:

--Five respondents said that utilities within their boundaries had adopted Public Utility Act standards/ requirements.

--Three respondents said that RCS Programs had been established,

--Two respondents said that conservation plans are required of utilities within their boundaries.

--One respondent said that programs to establish building codes/interest-free weatherization loans were in effect.

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[1]The Public Utility Act was enacted to provide States with a mechanism to foster conservation of energy supplied by electric utilities, optimize efficient use of facilities and resources by electric utilities, and promote equitable rates to electricity consumers. The act also establishes ratemaking and regulatory standards for electric utilities. Its rate and regulatory standards are reported by some States when responding to questions concerning their intent to adopt or adoption of conservation programs or activities.

--One respondent said that DOE's innovative rates programs to low-income consumers had been established.

--One respondent said that utilities within its boundaries get an increased rate of return for conservation measures promoted.

These responses indicate, at least to some extent, that State conservation program efforts appear related to some Federal effort and that States rely on the utilities to implement most conservation measures. This relationship between Federal and State conservation efforts becomes even more apparent when we compare the responses to our questionnaire with the data collected by NARUC. For example, five respondents to NARUC indicated they had adopted the Public Utility Act standards. Four respondents to our questionnaire (see chart on p. 16) said that they have programs which appear, at least to us, similar to the Public Utility Act regulatory or rate standards because they are one of the following kinds of efforts: information programs, prohibition of master metering, customer rates, or load management. Three other respondents to NARUC said that Residential Conservation Service Programs funded solely by the State had been established. Seven respondents to our questionnaire also responded that an RCS Program was in effect. Since the Federal Government (actually, DOE) is responsible only for making sure that utilities within each State establish an RCS plan (see RCS Program details in app. II), some responses may have been made on the basis of State funds spent to monitor utility progress in developing RCS plans. Responses to neither NARUC's nor our inquiries show regional trends because it appears that few States fund conservation efforts.

## UTILITY-FOSTERED CONSERVATION PROGRAMS

Some utilities incur the cost of fostering conservation programs, while other utilities are permitted by State regulators to incorporate such program costs in customer rates. In either case, we were unable to determine whether utilities absorb or pass on to customers the cost of fostering conservation programs. However, evidence of a strong relationship between federally funded conservation efforts and actions taken by utilities with State sanction is found in an Electric Power Research Institute (EPRI) report issued in November 1982 which surveyed the conservation activities of some members of various utility associations. The EPRI report indicates that contacts were made with Edison Electric Institute, the National Regulatory Electric Cooperative Association, and the American Public Power Association to obtain information on the number of utilities engaged in conservation efforts at December 31, 1981. A number of utilities were found to be conducting activities required by the Residential Conservation Service Program. For example,

--Edison Electric Institute reported that 137 of 190 members (72 percent) were involved in the RCS Program;

--National Regulatory Electric Cooperative Association reported that 11 members (about 1 percent) have implemented RCS-prescribed programs, while 739 (about 81 percent) of 908 members were conducting energy audits as part of a 1980 conservation program; and

--American Public Power Association reported that 46 (about 3 percent) of 1,400 member utilities carry out RCS Programs, while most other members carry out other energy conservation efforts.

In addition, the National Regulatory Electric Cooperative Association gathered other conservation program statistics which indicate that

--208 members have energy conservation loan programs and

--38 members sell weatherization (15 members also install the materials while another 2, which do not sell weatherization materials, only install).

The EPRI report continued by identifying 96 utilities involved in implementing 207 conservation programs. Several of these programs appear closely related to mandated Federal RCS Programs. We reviewed the EPRI data indicating programs fostered by utilities and found that seven programs were implemented most often. The following table indicates the number of utilities that employ those seven programs.

Table 1

Number of Utilities Having a Specific Conservation Program in Effect at December 31, 1981

| Number of utilities | Program |
|---|---|
| 50 | Energy audits |
| 20 | Awards and incentives |
| 15 | Financing |
| 12 | Materials |
| 11 | Project demonstration |
| 10 | Promotional sales |
| 7 | Installation |

CONSERVATION EFFORTS

Conservation efforts, coupled with the state of the economy, appear to have caused some utilities to call on customers to use more electricity and pay less for the additional use. For

example, according to recent news articles and industry publications, Con Ed of New York encouraged electric companies to which it supplies electricity to move into economically depressed areas or expand their present sales of electricity. In return these electric companies can receive a discount of up to 25 percent for 5 years on any extra electricity used. Con Ed is encouraging the additional use in order to use up its capacity that otherwise will not pay for itself. While several utilities in the Midwest and Northwest are also considering similar actions, such as Bonneville Power in the Northwest calling on local industries to use more electricity but pay less for the additional supply, three other Northeast power companies have proposed to take action similar to Con Ed's: Narragansett Electric Company, Providence, Rhode Island; Philadelphia Electric Company, Philadelphia, Pennsylvania; and Public Service Electric and Gas Company, Newark, New Jersey.

In the Southeast, industry publications indicate that the State of Alabama has proposed a discount in electric rates to the industrial sector in order to spur development. However, the Alabama Power Company has rejected this State proposal on grounds that discounts to the industrial sector would discriminate against other classes of customers.

Even in Canada, conservation efforts, at least in part, may have contributed to a recent electricity surplus. For example, Ontario Hydro, the big Provincial utility, 10 years ago advised customers to save-a-watt by using energy wisely. The campaign may have contributed to the current large generating surplus. To alleviate the present surplus, Ontario Hydro has asked homeowners who heat with oil to switch to electricity. This proposal is aimed not only at using the surplus electricity but also at reducing oil consumption.

OBSERVATIONS

--We were unable to determine the number of conservation programs that are funded solely by a State or utility. However, we were able to determine that most conservation programs fostered by States are usually carried out by utilities and those programs appear to have some relationship to Federal programs. Two Federal conservation efforts that seem to spark most State or utility conservation efforts are the RCS Program and the requirements of the Public Utility Regulatory Policies Act.

--Even when State or utility conservation efforts are identified, it is difficult to measure (quantify) the effect of the program in terms of reducing electric energy use because results are unmonitored.

--Currently, some believe that the widespread surplus electric energy situation has resulted from the state of

the economy rather than from conservation efforts. But since some conservation efforts have been widely advertised and implemented, conservation efforts also may have worked.

--Based on the data available to us, no regional trends in the use of specific conservation efforts are apparent.

## USE OF MARGINAL OR INCREMENTAL COSTS

The terms "marginal and incremental" are often used interchangeably (synonymously) when discussing cost formulation methods to produce electric utility rates. Simply defined, marginal or incremental costs are the change in total costs associated with a change in the quantity of supply or load.[1] Beyond this simplistic definition, a wide range of opinion exists as to how marginal or incremental costs should be reflected in rates or even how they are reflected in existing rate designs. Practical limitations restrict the use of precise marginal or incremental cost methods; therefore, a wide range of rate designs exists which incorporates, to some extent, a marginal or incremental cost basis of producing and delivering electricity to specific classes of customers. For example, two types of pricing perceived as marginal or incremental in nature are (1) time-of-day rates and (2) seasonal rates. While both attempt to reflect the change in production costs brought on by a change in the amount of electricity needed, some experts assert that the two rates are examples of pricing that are not truly marginal or incremental.

Marginal or incremental cost methods to formulate electricity rates are mechanisms considered useful and effective in fostering conservation because the price of energy is often the driving force in achieving energy conservation. Also, using marginal or incremental cost methods to formulate customer rates could more accurately reflect the additional costs brought about by the need for additional energy. In this regard, we attempted to determine the extent to which marginal or incremental cost methods are used.

### THE QUESTIONNAIRES

#### Results of GAO's questionnaire

We mailed a questionnaire to each of the 50 States and the District of Columbia.[2] Of the 51 public utility commissions queried, 43 (84 percent) responded. Of these 43 responding, 13 (30 percent) stated that some or all of the electricity sold within their States' jurisdiction was sold using a marginal or incremental cost method to formulate the rate. The amounts of electricity sold within those States reporting the use of marginal or incremental cost methods ranged from one one-thousandth

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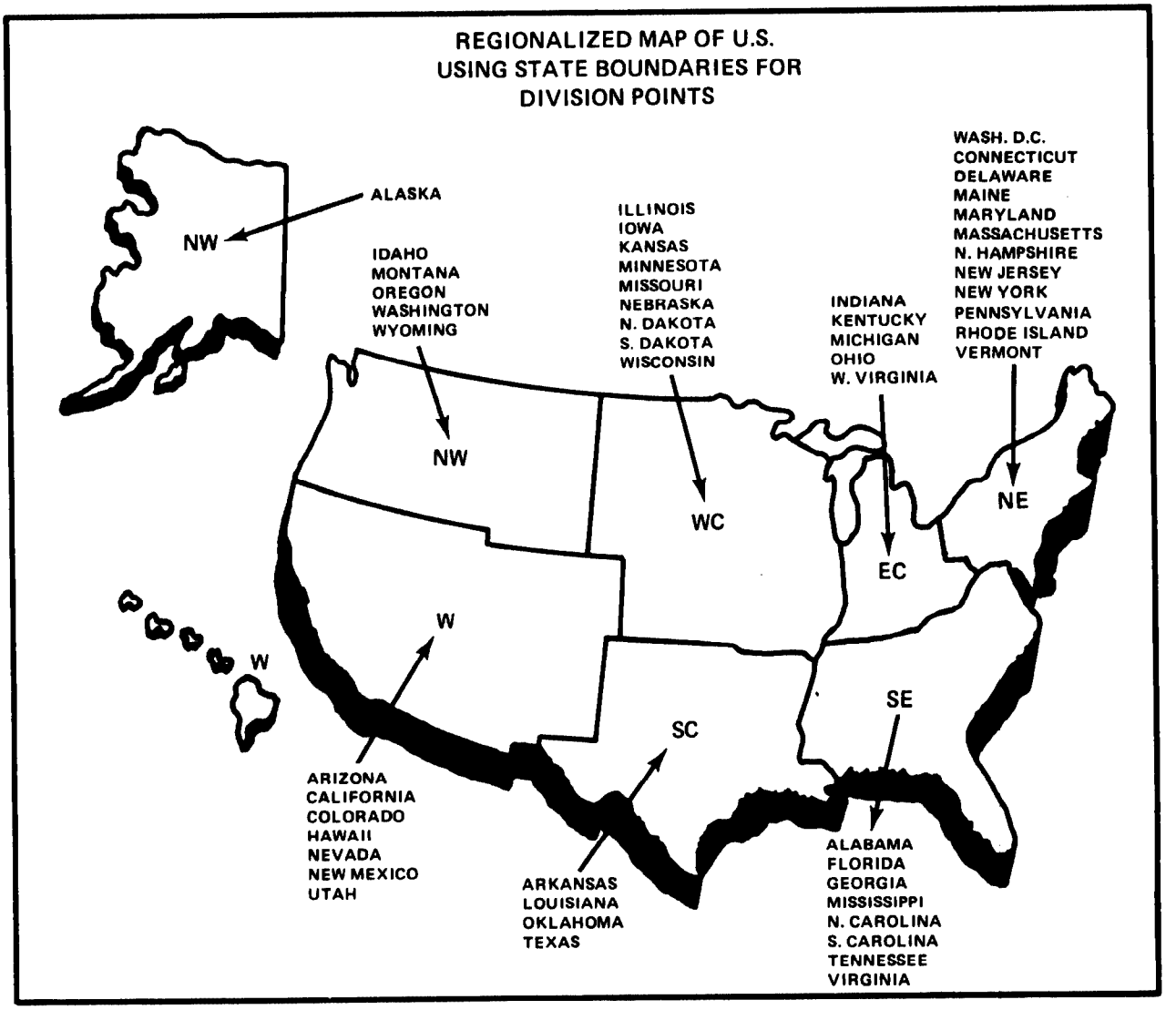
[1]The terms "supply" and "load" mean the amount of electric power generated, transmitted, or distributed within any system.

[2]Basically our questionnaire asked, "Did any utilities under your jurisdiction use retail rate structures based on marginal or incremental costs during the latest 12-month period for which you have complete data?"

of one percent (0.001 percent) to one-hundred percent (100 percent) of total electricity sales. In responding to our questionnaire some State officials stated that customer rates were based on a marginal or incremental cost method. However, limitations on the amount of revenue permitted by regulators and ratesetting which requires averaging raise questions as to the validity of statements that marginal or incremental cost/price methods are used 100 percent of the time. These percentages amount to electric sales ranging from about 57,000 megawatt-hours (MWHs) to about 132 million MWHs.

The following map shows our regional breakdown. We included Alaska in the Northwest, Hawaii in the West, and the District of Columbia in the Northeast. We designed the regions to permit observations on regional trends in the use of marginal or incremental cost methods.



Of those States that responded, the following table shows, based on our regions, the number of States that have used marginal or incremental cost methods within their boundaries.

Table 1

Number of States, by Region, That Responded to Our Questionnaire and Indicated Use of Marginal or Incremental Cost Methods at December 31, 1981

| Northeast | | Southeast | | East central | |
|---|---|---|---|---|---|
| St. res.[a] | St. use[b] | St. res. | St. use | St. res. | St. use |
| 9 of 12 | 4 | 6 of 8 | 2 | 4 of 5 | - |

| West central | | South central | | Northwest | |
|---|---|---|---|---|---|
| St. res. | St. use | St. res. | St. use | St. res. | St. use |
| 9 of 9 | 3 | 4 of 4 | - | 5 of 6 | 2 |

| West | | Total | |
|---|---|---|---|
| St. res. | St. use | St. res. | St. use |
| 6 of 7 | 2 | 43 | 13 |

[a]St. res. = States within the region that responded.
[b]St. use = States where utilities use marginal or incremental cost methods.

For the 13 states (25 percent of the total 51 queried) that reported utilities using marginal or incremental cost methods within their boundaries, no regional trend of such use is apparent.

The alternative to marginal or incremental cost methods is embedded cost[3] methods. In responding to our questionnaire, two States reported that utilities within their boundaries are moving from embedded cost methods toward the use of marginal or incremental cost methods to formulate electric utility rates.

Results of NARUC's questionnaire

As part of this effort, we reviewed NARUC data that indicate the use of marginal or incremental costs, by utilities, for the period ending December 31, 1981. Data are provided for utilities operating within 20 States. The following table shows the responses of those 20 State commissions. The State commissions were asked because they are a focal point for collecting data on utilities operating within their boundaries.

[3]Embedded costs are moneys already spent for investment in plant and operating expenses.

We would like to note that NARUC asked two questions: (1) what State law, regulation, or commission policies have been enacted or adopted to effect energy conservation by utilities with regard to marginal cost pricing and (2) whether any of the cost methods used by utilities measure marginal or incremental costs for each customer class. In contrast, we asked if any utilities under a State's jurisdiction use retail rate structures based on marginal or incremental costs. Although the questions are phased differently, we expected responses to be reconcilable since cost methods are usually carried forward into pricing methods. However, we do recognize that a utility can employ marginal or incremental cost without marginal or incremental pricing, or vice versa. Because of the inconsistent responses, we followed up on the respondents to our questionnaire and note the reasons for the inconsistencies later in this appendix.

According to the NARUC survey, utilities in eight States employ marginal pricing policies. Utilities in seven other States said that marginal pricing is being proposed or tested. Two States have utilities that use marginal pricing only for the electric industry--most States that use marginal pricing use it for all utilities, including water and gas. The remaining three States reported that marginal pricing (1) existed at some utilities as well as being proposed for other utilities, (2) was adopted in principle as a tool for billing customers, or (3) was used to adjust charges for hotels/casinos in Atlantic City, New Jersey.

Included in the NARUC study are data pertaining to State-fostered or allowable conservation activities. Table 2 indicates as of December 31, 1981, the number of States, within our regional designations, that have adopted policies, laws, or regulations promoting energy conservation by utilities through marginal cost pricing. We used our regional breakdown to display the NARUC data because it permits an easier comparison with our data.

Table 2

Number of States, by Region, That Indicate State Law, Regulation, or Commission Policies Have Been Enacted or Adopted to Effect Energy Conservation by Utilities' Use of Marginal Cost Pricing at December 31, 1981

| Northeast | Southeast | East central | West central | South central |
|---|---|---|---|---|
| 7 of 12 | 2 of 8 | 2 of 5 | 2 of 9 | 2 of 4 |

| Northwest | West | Total number of States where marginal cost pricing is considered |
|---|---|---|
| 1 of 6 | 4 of 7 | 20 |

In addition, the NARUC study provides data on the use of marginal or incremental costs for each class of customer by utilities and whether a State commission requires this type of costing. This was NARUC's second question. Table 3 shows the number of States within our regional designations that have indicated that marginal or incremental costs methods are used to determine the rate by class of customer at December 31, 1981.

Table 3

Number of States, by Region, That Have Marginal or Incremental Cost Used by Utilities to Determine the Rate To Be Applied to Each Class of Customer at December 31, 1981

| North-east | South-west | East central | West central | South central |
|---|---|---|---|---|
| 3 of 12* | 3 of 8* | 1 of 5 | 3 of 9* | 0 of 4 |

| North-west | West | Total number of States where marginal or incremental cost methods are considered |
|---|---|---|
| 3 of 6* | 2 of 7* | 15 |

*An asterisk indicates that one of the States within that region requires a marginal or incremental cost method to measure changes in capacity to meet demand. A total of five States indicated that they had this requirement.

Comparison of NARUC's data with our data

Table 4 compares our recent questionnaire with the States' responses to the NARUC update of December 31, 1981. It should be noted that even though some States responded in the affirmative to NARUC's question pertaining to the use of marginal or incremental cost methods by utilities, some of the same States responded negatively or did not respond to our question on whether utilities use marginal or incremental cost methods to formulate rates. However, the NARUC update asked two questions: (1) Was pricing based on marginal costing promoted as a conservation effort by the State? (2) Were utilities using marginal or incremental cost methods? In contrast, our questionnaire simply attempted to inventory the number of States where utilities use marginal or incremental cost methods to formulate rates.

Table 4

Comparison of NARUC's Updated Data With Our Questionnaire Results

Update December 31, 1981, Per NARUC Study

| State | NARUC questionnaire: State-adopted or mandated conservation by utilities through marginal cost pricing | NARUC questionnaire: Utilities' use of marginal or incremental cost methods | Our questionnaire: Do utilities in your State use marginal or incremental cost methods? |
|---|---|---|---|
| Maine | X | N/R | No |
| Massachusetts | X | N/R | No |
| New Jersey | X | N/R | N/R |
| Mississippi | X | N/R | N/R |
| Michigan | X | N/R | No |
| Missouri | X | N/R | N/R |
| Oklahoma | X | N/R | No |
| New Mexico | X | N/R | No |
| Nevada | X | N/R | No |
| Alabama | N/R | X | No |
| Idaho | N/R | X | No |
| District of Columbia | N/R | N/R | X |
| Utah | N/R | N/R | X |
| Connecticut | X | X | No |
| Indiana | X | X | N/R |
| Arkansas | X | X | No |
| Arizona | X | X | N/R |
| Vermont | X | N/R | X |
| North Carolina | N/R | X | X |
| Illinois | N/R | X | X |
| North Dakota | N/R | X | X |
| Montana | N/R | X | X |
| New Hampshire | X | X | X |
| New York | X | X | X |
| Virginia | X | X | X |
| Wisconsin | X | X | X |
| Oregon | X | X | X |
| California | X | X | X |

NOTE: X = Indicates an affirmative response.
No = Indicates a negative responses.
N/R = Indicates no response.

Of the 28 States that responded to either our questionnaire or NARUC's updated questionnaire,

--nine States told NARUC that they have adopted or mandated marginal pricing within their boundaries;

--four States told NARUC that they have either adopted (allow) or mandated the use of marginal pricing and marginal cost methods by utilities;

--four other States affirmed that they have marginal cost methods used by utilities within their boundaries by so responding to both NARUC's update and our questionnaire; and

--six States affirmed that both marginal pricing and costing are used within their boundaries because they so responded to both questions asked by NARUC's update and our questionnaire.

Moreover, 10 States responded negatively to our question concerning the use of marginal or incremental cost methods within their boundaries. However, eight of these States indicated that they had adopted or mandated marginal cost pricing by utilities when asked by NARUC, and two States indicated that utilities used marginal or incremental cost methods.

As a result of the unexpected inconsistencies between NARUC's data and data from our questionnaire, we followed up on those respondents to our questionnaire to determine what may have caused the apparent differences. We found that the inconsistencies between these data are the result of (1) different respondents' interpretations of what each questionnaire was asking, (2) different views concerning the meaning or use of marginal or incremental cost, and/or (3) different individuals responding to each questionnaire.

## OBSERVATIONS

Based on the results of our survey, the use of marginal or incremental cost methods to formulate electric rates does not appear to constitute a trend in any region of the country. On a national basis, marginal or incremental cost methods are used in as few as 13 States or as many as 26 States, depending on the accuracy of the responses to either NARUC's update or our questionnaire.

## STATUS OF THE ENERGY SERVICES INDUSTRY

When an industrial plant, business, or homeowner wants to efficiently use energy to reduce its associated costs, help is usually needed. Such assistance usually comes from the energy services industry or related industries. Although definitions of the energy services industry vary, we have defined it as the industry capable of determining the need for and having the ability to install and/or finance energy efficiency improvements. We include related industries even though they may provide other services in addition to energy efficiency improvements.

Professionals and firms of many types are involved in the business of decreasing energy consumption. Though a list of such groups would be long, the list would consist of architects, engineers, contractors, energy management/service companies, manufacturers, and retailers that form the core of the industry. Other participants that make up the industry are utilities, nonprofit corporations, and community groups.

## FEDERAL AND STATE INITIATIVES AID IN ESTABLISHING THE ENERGY SERVICES INDUSTRY

Rising energy prices and the energy shortages of the 1970's caused enactment of Federal and State laws and programs which encouraged energy efficiency activities by just about everyone. While raising prices may have caused some conservation efforts, States and Federal actions provide detail on how to implement energy conservation measures. Most affected by these initiatives, however, have been those in the residential sector. Some of the more important actions taken include the National Energy Conservation Policy Act (NECPA),[1] State programs, the Federal low-income weatherization program, and Federal and State tax credits.

NECPA requires utilities to have energy conservation programs which provide consumer information and services at customer expense. Utilities are to provide customers with information on suggested efficiency measures for buildings; energy cost-saving techniques; utility-arranged energy use inspections of energy-saving devices, including their financing; and other conservation measures. In addition, utilities are to arrange for specific services--inspections or energy audits, installation of equipment, and loans. Twenty States have laws, regulations, or public utility commission policies which require that utilities provide energy audits. However, in 12 of these 20 States, audits are for the residential sector only. In 4 of the 20 States, such programs are still being tested. According to some RCS officials

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[1]NECPA (Public Law 95-619, Nov. 9, 1978) created the Residential Conservation Service (RCS), among other programs.

and other energy experts, the RCS audit requirement has been partly responsible for the rapid growth of contractors and suppliers. Further, in some areas consumer groups are working with utilities to provide audit and installation services to communities. In Massachusetts, for example, one utility contracted with a community organization to operate an audit outreach program.[2] In San Diego a municipal advisory group and a utility are considering having the advisory group provide RCS audits, installation, and financing to low-income customers.[3]

States, according to the National Energy Conservation Policy Act, must prepare and update a list of qualified contractors as part of their RCS Programs. In the 13 States we contacted, the size of the lists varied widely, from 60 contractors in Maine to 130,000 in California. These numbers, however, may be misleading because several RCS officials said that some lists do not include all of the contractors within the State. They attribute the lists' incompleteness to one or more of the following reasons:

--When States develop lists of known service industry companies, States do not verify that all eligible firms have applied for inclusion on the list.

--One State requires a certain level of liability insurance which some firms may not carry.

--While businesses are responsible for submitting their names for placement on the list, not all choose to do so. Some companies fear participation may imply association with others less qualified or believe the list is not used enough to provide them with any advantage.[4]

--Several of the lists, which were developed between 1980 and 1981, have not changed much since they were developed and little or no effort has been made to update them.

Based on these statements, many firms capable of performing energy efficiency services may exist beyond those mentioned on existing lists. In any event, some lists have been useful to inform the public of available energy services by making company names available.

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[2]California Energy Commission, Delivering Energy Services, p. 127.

[3]Ibid.

[4]A study done for DOE under contract showed that in some States the lists' size has increased rapidly but that the use of the lists was limited. Although lists are given out with each audit, many people choose to do most work themselves.

Apart from the National Energy Conservation Policy Act, some State low- or no-interest loan programs provide the incentive needed to install conservation measures. Even the lists prepared under the RCS Program seem to be more effective when combined with loan incentives. For example, a study prepared for DOE concluded that contractors and suppliers are more active in States with low- or no-interest loan programs or other financial incentive programs.

Another Federal program influencing the supply of energy services is the low-income weatherization program funded by HUD. (See app. II.) In some places, nonprofit groups have used these funds to improve energy efficiencies in low-income areas. For example, a nonprofit group in Washington State has helped homeowners install insulation and other energy-saving measures using HUD funds.

The energy services industry is also stimulated by Federal and State tax credits. Federal and State tax credits offer consumers tax reduction of varying percentages for moneys spent making energy efficiency improvements in their building(s).

## STATUS OF THE ENERGY SERVICES INDUSTRY IS HARD TO ASSESS

The existence and future growth of the energy services industry cannot be fully assessed. Based on discussions with 17 industry contacts, 8 experts knowledgeable of the industry (3 from consulting firms and 5 from government), and 13 State officials familiar with the industry, we found mixed views about the extent of the industry's existence and possible future growth. These views stem from such factors as the industry's competitive nature, product appeal, and the state of the economy and government regulation, just to name a few.

Some industry association contacts foresee growth in the energy services industry. For example, the National Electrical Contractors had no members active in energy management in 1973 or 1974; however, as of March 1982, 46 percent of their members reported that they do some work in this area. Another example is the Association of Energy Engineers' 1980 survey from which it estimates that revenues will grow about 28 percent annually from performing energy services. Further, a representative of Associated Specialty Contractors, which is an association of eight associations, expects 20 percent of its member contractors' work to be in the category of energy efficiency over the next 3 to 4 years. Despite these expectations of growth, four commercial and industrial contacts said that the recession has hurt the industry. Six sources knowledgeable about residential trends also attributed the industry's problems, which may continue, to the economy and particularly with the slowdown in home building. Another residential market problem is the relative cost of improvements compared with the savings over a short payback period--the savings when compared with the costs take too long to be realized--according to two sources.

Similarly, conflicting information came from insulation associations. One such group sees the industry's potential for growth in the "new buildings" market, where buyers are more conscious of energy use. Another group saw less potential in this area, saying that builders are cutting back on some insulation to reduce costs.

Utility and State officials also have differing expectations of the future growth of the energy services industry. One utility executive said that the industry is not necessarily growing--that many firms come and go. He said that "It [the industry] grew phenomenally at first." In 1976-77, some energy experts found only six contractors in the Yellow Pages of a large metropolitan area; now these same experts do not try to count them. Another utility executive in the same region said he sees more industry activity. Insulators in his area are very active, with business growing mostly in retrofitting existing homes until new-home building increases. One other utility executive from another region of the country agreed that he too has seen many companies come and go. However, while most State officials believe that the actual number of contracting companies exceeds what appears on their RCS lists, they differ on whether the number of firms is increasing or decreasing.

Two other factors affecting the service industry are economics and quality of service received by customers. For example, three industry observers stated that they believe the energy services industry is not doing well financially. One said that only a few companies have been successful and that Federal assistance is needed if the industry is to continue to exist. Another stated that the industry is young and many companies are barely staying in business. In addition, a few large companies are not doing very well either. The third observer said that service companies dealing with the commercial and industrial sectors are providing services but that their financial health is in jeopardy because of the recession.

Further, according to some experts, utilties which provide energy services get mixed ratings on the quality of service they provide. Some utilities which were forced into providing energy audits, because of RCS Program requirements, have reluctantly set up such programs. Consequently, some energy audits are not rated worthwhile. Utilities having a financial incentive, such as high energy prices, limited capacity, or high demand, are more likely to develop effective energy efficiency programs, according to one source.

## POTENTIAL MARKETS FOR ENERGY EFFICIENCY IMPROVEMENTS EXIST

Apart from the current state of the industry as a whole, industry sources, industry experts, and State officials commented

that they see potential for greater marketing of energy efficiency improvements. Customers' previous contacts, word of mouth, and the Yellow Pages seem to be the main ways of finding those contractors needed for specific services. Some associations have recognized this need to market (publicize) the industry. Although the RCS master lists have been criticized for not providing any more information than a telephone book, one source credited these lists as a beginning to provide consumers with needed information on contractors and the services they provide.

Another way to provide energy efficiency improvements exists in the residential sector where entire neighborhoods can be assessed and improved as units. Two examples of this approach are the Residential Electrical Efficiency Program in New Jersey and the building ordinances of some California cities and counties. Under the Residential Electrical Efficiency Program, private companies audit homes on a neighborhood basis (many buildings in some neighborhoods are similarly constructed) and install the materials necessary to improve the buildings' energy efficiencies. These homes are evaluated both before and after installation of the energy-saving materials to determine the amount of energy saved. Then, according to a prearranged contract, the utility pays the companies based on the amount of energy saved. In certain California communities, building ordinances require dwellings to meet certain efficiency standards before they can be sold.[5] Such requirements lend themselves to work which provides a market for energy services. However, both Federal and State efforts need to be more widely known (publicized) for greater future effect.

The potential for energy efficiency improvements also depends on the condition of the economy and the price of energy. As mentioned earlier, many parts of the energy services and related industries have been hurt by the recession. One example is the insulation contractors, who have insulated 2-3 million new homes. Since the recession, however, two industry sources said that people are postponing decisions to insulate buildings. The price of energy also affects such decisions. For example, when energy prices are high, improvements are made more often. However, when prices of energy decrease, so does the incentive to install energy-saving materials such as insulation.

Few incentives for utility-fostered conservation efforts exist. According to one consultant[6] "less than 10 percent of

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[5]These communities include Davis, Livermore, Berkeley, Del Mar, Sacramento, and San Francisco as well as Santa Clara, Sacramento, Marin, and San Mateo Counties. California Energy Commission, Delivering Energy Service, p. 128.

[6]Judy Greenman, NERA, 9/81 testimony.

* * * [household and industry] energy consumption * * * is accounted for by electricity * * * and * * * only 16 percent of the housing units in this country are heated with electricity, and many of those are very well insulated." This consultant also asserts that

> "electric utilities have neither the incentive nor the means to subsidize energy conservation. Since in most parts of the country (the Pacific Northwest and TVA regions excluded) conservation will affect the consumption of fossil fuels much more than electricity, the electric utility industry has little independent incentive to promote general energy conservation--the benefits of conservation are not captured by the utilities or by electricity consumers."

Other experts claim that despite these facts, utilities can meet some market needs. They believe this because utilities are known by their customers and are more likely to be trusted; thus, utilities' conservation efforts would have positive public reaction.

ENTERING THE INDUSTRY IS EASY

Firms can enter the market fairly easily since a high capital investment is not needed. Further, no special training is required: very few associations have certification procedures and no outside body regulates the qualifications of individual contractors or companies. Likewise, firms can exit just as easily. This condition has enabled some "fly-by-night" companies to exist. Thus, some utility and State officials reported that reputable firms try to avoid any connection with such companies. To help alleviate the problem, one industry association suggested that the government regulate contractors to protect the public and reliable firms.

Another factor to consider in assessing the industry is the firm's size. Contractors can work individually or as a member of a group. Engineering and architectural firms are typical of such groups. Other groups are likely to consist of trained energy auditors. Energy service companies can consist of 1 consultant or 100, depending on the type of services provided. In addition, some utilities provide a variety of services with a staff consisting of energy auditors to engineers. While there are many firms able to provide some energy efficiency service, the industry is so diverse in individual firm size and consists of such a mix of disciplines that it is difficult to quantify the number of large, medium, and small firms that make up the industry.

BARRIERS REMAIN TO FUTURE EXPANSION OF THE INDUSTRY

Product appeal is another factor to consider when assessing whether or not the energy services industry is alive and well.

Consumer knowledge about products and costs is crucial to the industry's development. According to several sources, people are much more aware of the benefits of reducing energy use than they used to be. However, according to some industry contacts, some actions to reduce energy use are not taken because of a lack of information.

Common, but often incomplete, sources of information on these industries include word-of-mouth, prior contacts, the Yellow Pages, and the RCS master lists. While word-of-mouth and prior contacts may be trustworthy, they are not universally available. Yellow Page advertisements provide limited information that individuals can use to judge a contractor. Not all types of contractors can be found easily in the Yellow Pages, though, according to one expert. He asserts that while insulation contractors are easy to find, other suppliers or services are difficult to find.[7]

Even the RCS master lists are incomplete sources of information. According to a study done for DOE, "the list(s) have helped in a few cases to introduce consumers to specialized services, such as solar hot water installers, or to familiarize new residents with contractors in their areas." Many RCS lists provide only a firm's name, address, and phone number. Thus, the lack of information decreases their usefulness.

## THE ECONOMY AND GOVERNMENT REGULATIONS AFFECT THE INDUSTRY'S DEVELOPMENT

The economy and government regulations also influence the current and future status of the energy services industry. Many observations and comments made by industry and other officials addressed these two areas.

When the economy is in poor straits, as it was in the 1981-82 recession, getting capital for energy efficiency improvements can be a problem. Even when capital is available, high interest rates can discourage borrowing, especially where minimal financial return or financial return over a long period of time will be obtained. Several industry sources stated that when the recession ends the industry should revive.

Economic disincentives to energy efficiency improvements sometimes exist when buildings are rented or when the improvements cost too much relative to the financial savings to be earned. When buildings are rented, the tenants generally have no

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[7]These suppliers or services include furnace efficiency modifications; clock thermostats; load management technologies like radio and computer controls; and solar and wind machines.

incentive to make energy efficiency improvements because the benefits (reduced energy cost) usually take time to accrue. On the other hand owners have no incentive to make energy efficiency improvements when the utility bills are paid by the tenants. These situations are particularly prevalent in the small commercial sectors, where 75 percent of the buildings are tenant occupied. In the residential sector, financial incentives are often not high enough. According to one source, while a homeowner might pay $15 for an energy audit of his or her own home, tenants are not willing to invest in another's property unless costs can be recovered quickly.

Federal efforts to provide incentives

Federal activities have made three types of information available. First, the Department of Housing and Urban Development and Department of Energy provide literature on energy-saving techniques and technologies to those who order it. Second, energy efficiency ratings are required by the Federal Trade Commission for residential appliances. Such information can help consumers make more informed decisions. Similar information is not required, though, for commercial appliances. Commercial enterprises have to depend upon salespeople for such information. Third, energy services information is made available through the Federal RCS Program requiring local utilities of a certain size to distribute a list of energy efficiency improvement contractors, suppliers, and financial supporters of such projects.

The Federal Government is also involved in energy efficiency regulation. One example is shown in a Consumer Product Safety Commission study of cellulose insulation installed in many buildings. Of the buildings checked, 79 percent were found to have insulation incorrectly installed. Another example is the Federal Government's efforts to set product standards. Although these standards have not been implemented, many States have anticipated such regulations and started efforts to adopt Federal initiatives.

Some Federal regulatory requirements have been beneficial. According to one utility official we spoke with, the number of insulation contractors in his area has increased because the RCS Program established the need for insulation to improve energy efficiencies. He also reported that even though RCS funds have been cut back, the State-operated RCS Program not only exists but is expanding. In New Jersey, a House Doctor program was so successful that the utility is expanding it to other areas.

Through programs which supply funds, the Federal Government helps the development of the energy services and related industries. As mentioned earlier, HUD funds for weatherizing low-income dwellings have permitted some nonprofit groups to assist neighborhoods by providing energy efficiency services. Most Federal funds, according to one source, are spent for the low-income

weatherization program. Many low- to middle-income families who are not eligible for such funds defer the cost of improving energy efficiency, even though such action would reduce their utility bills over time. For middle to upper income families, some energy audits are provided by utilities at little or no charge. Finally, tax credits, an indirect Federal expenditure, benefit middle to upper class homeowners as well as businesses. In addition to existing energy tax credits for efficiency improvements, the 1981 Economic Recovery Tax Act allows some energy efficiency improvements to be depreciated rapidly.

Overall we believe the energy services industry exists to the extent that it can currently meet customer demands for energy efficiency improvements. However, specifically measuring the number of businesses capable of being part of the industry or the amount of energy efficiency improvements undertaken by the various sectors--commercial, industrial, and residential--would be impossible with any degree of accuracy because of the various factors that affect the industry.

## STATUS OF EXISTING POWERPLANTS AND TRENDS IN THEIR PERFORMANCE

Much published data are available on the characteristics of the Nation's powerplant inventory--number of units, capacity, fuel type, regional data--and on the performance of the powerplants--capacity factors[1] and availability. The main sources of these data are DOE and the North American Electric Reliability Council (NERC). In addition to these data, a number of studies have been done on the performance of certain categories of powerplants, two of which are mentioned later in this appendix.

Our analysis of the published data and review of other written material indicates that the generation as a percentage of capacity of existing powerplants is declining. However, it is beyond the scope of this review to accurately quantify the extent of this declining performance indicator or to recommend specific actions which could be taken to mitigate this occurrence.

The information that follows is presented in two parts. The first, "The Status of Existing Powerplants," is intended to provide a snapshot of the Nation's powerplant inventory in 1981--the number and capacity of plants, the kind of fuels they use, where they are located, and their productivity. The second section, "Trends in Powerplant Performance," provides some analysis of the published powerplant performance data for the 1970 to 1982 time frame. Data on both the powerplant status and trends are from the latest published documents.

### STATUS OF EXISTING POWERPLANTS

#### Total capacity by fuel type and age

In 1981, the Nation's utilities had a powerplant inventory of 10,772 units with a total nameplate[2] capacity of 640,888

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[1]Capacity factor is the ratio of the actual total generation of a powerplant to the nameplate capacity of the powerplant for a specified time period.

[2]Nameplate capacity is the full-load continuous rating of a generator under specified conditions as designated by the manufacturer. We will use nameplate capacity in this discussion of existing capacity because DOE regional and fuel data were consistently available on a nameplate capacity basis. Later, in discussing powerplant performance trends, we will use maximum dependable capacity (which is somewhat lower than nameplate capacities) because it is the more appropriate measurement of capacity in relation to performance.

megawatts representing a net investment of nearly $300 billion. Almost 79 percent started commercial operation after 1960. The age of this existing capacity is shown in table 1.

Table 1

Age of U.S. Powerplant Inventory

| In-service year | Percent of capacity | |
|---|---|---|
| | Actual | Cumulative |
| 1982 | 1.0 | 1.0 |
| 1980-1981 | 5.9 | 6.9 |
| 1975-1979 | 20.2 | 27.1 |
| 1970-1974 | 26.9 | 54.0 |
| 1965-1969 | 14.9 | 68.9 |
| 1960-1964 | 9.7 | 78.6 |
| 1955-1959 | 9.1 | 87.7 |
| 1950-1954 | 6.8 | 94.5 |
| Before 1950 | 5.6 | 100.0 |

Source: "Inventory of Power Plants in the United States 1981 Annual" (Energy Information Administration - DOE/EIA-0095(81)).

Coal is used to fuel more powerplant capacity in the United States than any other fuel, accounting for over 42 percent of existing installed capacity in 1981. Table 2 shows the number of units and capacity by fuel type as reported by the utility industry.

Table 2

Existing Capacity of U.S. Powerplants--1981

| Fuel type | Total no. of units | Capacity | |
|---|---|---|---|
| | | MWs | Percent |
| Coal | 1,332 | 271,723 | 42.4 |
| Oil | 4,396 | 151,055 | 23.6 |
| Gas | 1,639 | 75,311 | 11.7 |
| Water | 3,276 | 77,348 | 12.1 |
| Nuclear | 78 | 61,953 | 9.7 |
| Other | 51 | 3,403 | 0.5 |
| Total | 10,772 | 640,883 | 100.0 |

Source: "Inventory of Power Plants in the United States 1981 Annual" (Energy Information Administration - DOE/EIA 0095(81)).

Capacity by NERC region and fuel type

Although coal is the leading type of fuel used for capacity nationwide, the types of fuels used for capacity in the various NERC regions (see map on next page for locations of NERC regions and full name of regional acronyms) vary widely. The existing types of capacity in the NERC regions plus Alaska and Hawaii for 1981 are shown in table 3. For example, coal accounts for about 80 percent of the East central area's capacity, while the Northeast area's capacity is about 62 percent oil. Gas accounts for 70 percent of the Texas area capacity and 52 percent of the Southwest area's. In the Western area, hydropower accounts for 40 percent of capacity, followed by oil with about 29 percent.

Map of the
North American Electric Reliability Council's
Regionalization

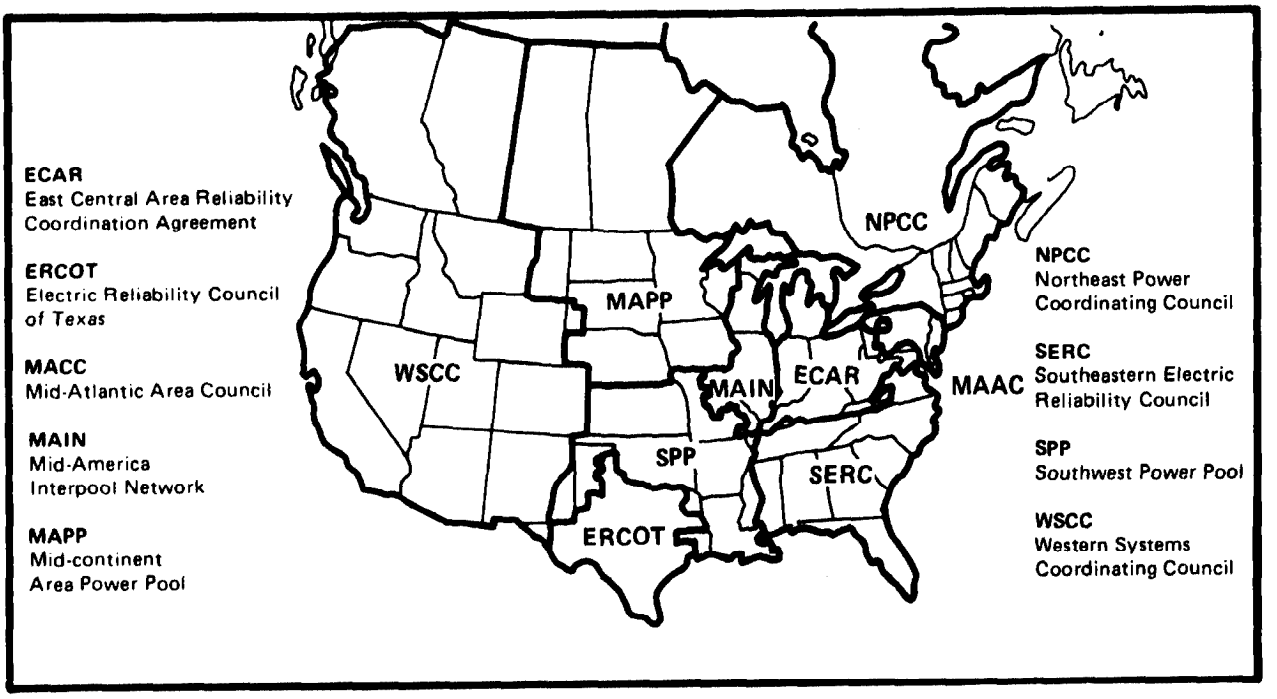


Table 3

1981 Existing Capacity (megawatts)

| Region | Nuclear | Coal | Oil | Gas | Water | Other | Total |
|---|---|---|---|---|---|---|---|
| ECAR | 5,157 | 81,701 | 9,785 | 1,335 | 3,271 | 152 | 101,401 |
| ERCOT | - | 10,656 | 2,578 | 32,198 | 285 | 226 | 45,943 |
| MAAC | 8,855 | 18,050 | 21,965 | 284 | 2,532 | 47 | 51,733 |
| MAIN | 7,300 | 33,084 | 7,557 | 471 | 1,017 | - | 49,429 |
| MAPP | 3,740 | 19,661 | 5,101 | 888 | 2,890 | 29 | 32,309 |
| NPCC | 8,545 | 3,466 | 33,176 | 108 | 7,695 | 135 | 53,125 |
| SERC | 22,679 | 63,154 | 30,955 | 3,537 | 13,333 | 73 | 133,731 |
| SPP | 1,845 | 17,940 | 6,926 | 32,170 | 2,629 | 610 | 62,120 |
| WSCC | 3,832 | 23,957 | 30,973 | 3,829 | 43,645 | 2,098 | 108,334 |
| Alaska | - | 54 | 486 | 491 | 137 | 33 | 1,201 |
| Hawaii | - | - | 1,553 | - | 4 | - | 1,557 |
| U.S. Total | 61,953 | 271,723 | 151,055 | 75,311 | 77,438 | 3,403 | 640,883 |

Source: "Inventory of Power Plants in the United States 1981 Annual (Energy Information Administration - DOE/EIA 0095(81)).

Likewise, the numbers and types of existing generating units vary widely among the various NERC regions. Table 4 shows the existing number of generating units in the NERC regions plus Alaska and Hawaii in 1981.

Table 4

| | Number of existing units in 1981 | | | | | | |
|---|---|---|---|---|---|---|---|
| Region | Nuclear | Coal | Oil | Gas | Water | Other | Total |
| ECAR | 7 | 411 | 400 | 116 | 292 | 2 | 1,228 |
| ERCOT | - | 17 | 42 | 294 | 31 | 2 | 386 |
| MAAC | 9 | 70 | 367 | 15 | 55 | 1 | 517 |
| MAIN | 10 | 191 | 376 | 102 | 195 | - | 874 |
| MAPP | 7 | 205 | 949 | 234 | 249 | 4 | 1,648 |
| NPCC | 14 | 39 | 503 | 13 | 629 | 3 | 1,201 |
| SERC | 24 | 224 | 518 | 107 | 532 | 3 | 1,408 |
| SPP | 2 | 69 | 467 | 591 | 101 | 7 | 1,237 |
| WSCC | 5 | 101 | 441 | 146 | 1,153 | 28 | 1,874 |
| Alaska | - | 5 | 262 | 19 | 35 | 1 | 322 |
| Hawaii | - | - | 71 | - | 4 | - | 75 |
| U.S. Total | 78 | 1,332 | 4,396 | 1,639 | 3,276 | 51 | 10,772 |

Source: "Inventory of Power Plants in the United States 1981 Annual" (Energy Information Administration - DOE/EIA 0095 (81)).

Powerplant production by fuel type and region

During 1981, the Nation's powerplants generated a total of 2,294,812 gigawatthours[3] (GWHs) of electricity as shown in table 5.

Table 5

U.S. Powerplant Production - 1981

| Energy source | Gigawatthours | Percent |
|---|---|---|
| Coal | 1,203,203 | 52.4 |
| Gas | 345,777 | 15.1 |
| Nuclear | 272,673 | 11.9 |
| Water | 260,684 | 11.3 |
| Oil | 206,070 | 9.0 |
| Other | 6,405 | 0.3 |
| Total | 2,294,812 | 100.0 |

Source: "Electric Power Annual 1982" (Energy Information Administration - DOE/EIA, Nov. 1982, p. 28).

While coal accounted for 42 percent of capacity in 1981, it accounted for 52 percent of generation. This higher percentage of coal-fired generation over capacity reflects the economic advantage of using coal over a more expensive fuel such as oil. Similarly, oil accounted for about 24 percent of capacity but only 9 percent of generation, a fact that reflects the cost disadvantage of using oil over the less expensive coal in 1981.

The total net generation by NERC region plus Alaska and Hawaii during 1981 is shown in table 6.

[3]A gigawatthour is equal to one billion watthours, one million kilowatthours, or one thousand megawatthours of electricity.

Table 6

| Region | 1981 total net generation (thousand GWH) Nuclear | Coal | Oil | Gas | Water | Other | Total |
|---|---|---|---|---|---|---|---|
| ECAR | 26.5 | 369.1 | 4.7 | 1.9 | 1.8 | - | 404.0 |
| ERCOT | - | 59.7 | 0.7 | 103.7 | 0.8 | - | 164.9 |
| MAAC | 32.5 | 87.7 | 22.9 | 8.3 | 2.1 | 0.3 | 153.8 |
| MAIN | 39.0 | 114.1 | 5.6 | 1.3 | 2.2 | - | 162.2 |
| MAPP | 18.6 | 67.9 | 0.2 | 1.1 | 13.5 | 0.1 | 101.4 |
| NPCC | 43.2 | 18.9 | 78.0 | 12.4 | 30.3 | - | 182.8 |
| SERC | 91.4 | 281.1 | 53.4 | 17.7 | 20.8 | - | 464.4 |
| SPP | 9.1 | 76.6 | 5.2 | 118.4 | 2.9 | 0.1 | 212.3 |
| WSCC | 12.4 | 127.8 | 28.5 | 79.1 | 185.7 | 5.9 | 439.4 |
| Alaska | - | 0.3 | 0.4 | 1.9 | 0.6 | - | 3.2 |
| Hawaii | - | - | 6.5 | - | - | - | 6.5 |
| U.S. Total | 272.7 | 1,203.2 | 206.1 | 345.8 | 260.7 | 6.4 | 2,294.9 |

Source: Developed from data in "Electric Power Annual 1982" (Energy Information Administration - DOE/EIA, Nov. 1982 pp. 30-33).

## Current reserve margins

Reserve margin is the difference between system capability at the time of peak demand and the system peak demand. This difference is sometimes expressed as a percentage of peak demand. A reserve margin of 20 percent is generally considered by the industry as necessary to provide reliable electric service. However, as seen in table 7, reserve margins vary by region.

DOE calculated the installed reserve margins for the 1982 summer and winter peak periods for each NERC region and the contiguous United States from industry-supplied capacity and demand data. These calculations were based on DOE's estimating the total capacity for electric utilities in the summer of 1982 at about 583,000[4] megawatts. This represents the maximum amount of power that would have been generated in the United States if all powerplants were operated simultaneously and at their full capacity. DOE then estimated the peak demand for electricity in the summer 1982 at about 441,000 MWs, leaving a 32 percent gross reserve margin not used to meet demand. This reserve margin after adjustments for outages is reduced to about 9.7 percent.

[4]This 583,000 MWs represent dependable capability which is somewhat less than nameplate capacities used earlier.

While this reserve margin represents the average for the United States as a whole for the summer of 1982, there are differences among individual NERC regions. We summarized the DOE calculations for each NERC region and the contiguous United States. We used the summer reserve margins in our summary because all but one NERC region had its peak demand during the summer months. Table 7 summarizes reserve margins for the summer of 1982.

Table 7

Reserve Margins by NERC Region for the Summer of 1982

| Region | ECAR | ERCOT | MAAC | MAIN | MAPP | NPCC | SERC | SPP | WSCC | U.S. |
|---|---|---|---|---|---|---|---|---|---|---|
| Total capacity (GW)[a] | 88.9 | 43.5 | 45.5 | 43.1 | 28.1 | 51.7 | 122.1 | 58.7 | 100.7 | 582.7 |
| Peak demand (GW) | 64.9 | 34.1 | 34.8 | 34.5 | 20.5 | 35.8 | 92.6 | 45.3 | 78.6 | 441.3 |
| Total reserves (GW) | 24.0 | 9.4 | 10.7 | 8.6 | 7.6 | 15.9 | 29.5 | 13.4 | 22.1 | 141.4 |
| Reserve margin (%) | 37.0 | 27.6 | 30.8 | 24.9 | 37.0 | 44.4 | 31.9 | 29.6 | 28.1 | 32.0 |
| Maintenance outages (%) | 10.1 | 4.3 | 5.2 | 3.5 | 4.6 | 11.5 | 6.8 | 1.9 | 9.2 | 6.9 |
| Forced outages (%) | 10.3 | 4.4 | 13.8 | 9.0 | 7.7 | 9.7 | 9.9 | 9.5 | 6.0 | 9.0 |
| Other unavail. cap. (%)[b] | 10.0 | 8.1 | 3.0 | 11.2 | 2.3 | 8.6 | 6.5 | 3.3 | 4.4 | 6.4 |
| Unavailability (%) | 30.4 | 16.8 | 22.0 | 23.7 | 14.6 | 29.8 | 23.2 | 14.7 | 19.6 | 22.3 |
| Adjusted reserves (%) | 6.6 | 10.8 | 8.8 | 1.2 | 22.4 | 14.6 | 8.7 | 14.9 | 8.5 | 9.7 |

[a]Net dependable capability plus imports less exports.

[b]Other unavailable capability is that capability which is unavailable for load reasons other than scheduled maintenance or full forced outages.

Source: "DOE Electric Power Supply and Demand for the Continguous United States, 1982-1991" - June 1982.

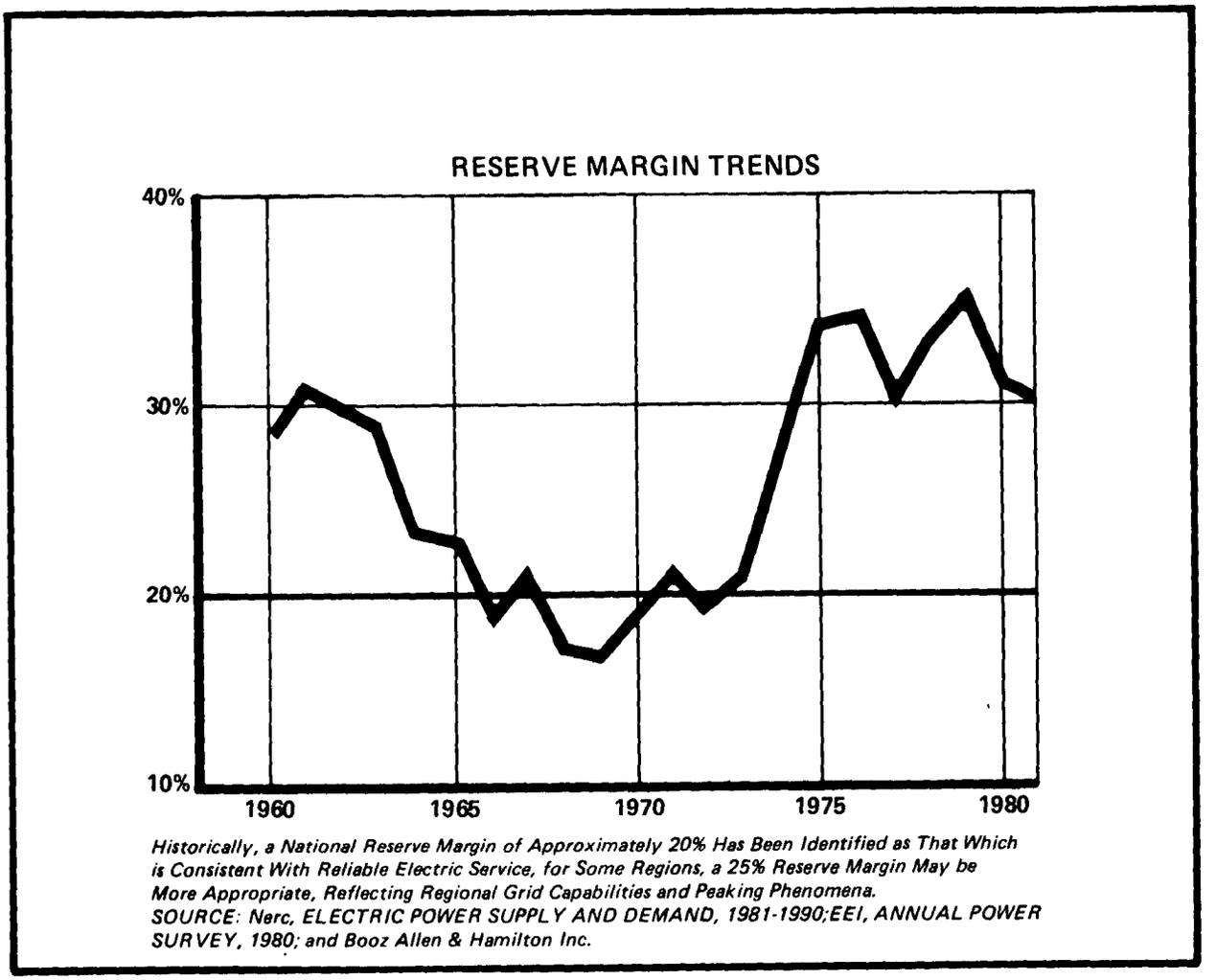
Winter reserve margins as determined by DOE were higher in all regions because demand is greater in the summer. The 1982 winter adjusted reserves stood at 17 percent for the entire Nation, versus the summer adjusted reserve of 9.7 percent.

## Trends in capacity and generation characteristics--1970 to 1982

We have just described the status of the Nation's existing powerplant inventory in terms of a number of characteristics--capacity, generation, fuel types, and reserve margins, to name a few. The 1982 inventory looks somewhat different from the 1970 inventory; we will briefly discuss how the characteristics of the Nation's powerplant inventory changed during the 1970's.

Reserve margins are higher

The consulting firm of Booz, Allen & Hamilton, Inc., prepared a report for DOE which included the following graph showing the total reserve margin trends for the U.S. electric generation industry.




*Historically, a National Reserve Margin of Approximately 20% Has Been Identified as That Which is Consistent With Reliable Electric Service, for Some Regions, a 25% Reserve Margin May be More Appropriate, Reflecting Regional Grid Capabilities and Peaking Phenomena.*
*SOURCE: Nerc, ELECTRIC POWER SUPPLY AND DEMAND, 1981-1990;EEI, ANNUAL POWER SURVEY, 1980; and Booz Allen & Hamilton Inc.*

This graph shows that reserve margin increased from slightly less than 20 percent in 1970 to a peak of about 35 percent in 1979. This increase was caused by increases in capacity, demand, and generation. After 1979, the reserve margin began decreasing slightly and declined to about 32 percent by 1982. However, as the consulting firm report indicated, a national reserve margin of approximately 20 percent has historically been consistent with reliable electric service (although some regions may require 25 percent), and recent margins have been somewhat higher than the 20 percent figure before adjustments.

Electricity generation by fuel type

In its 1982 Annual Energy Review to the Congress, DOE reported the following data on electricity generation by fuel type for the years 1970 to 1982:

Table 8

Thousand Gigawatthours of Electricity

| Year | Coal | Oil | Gas | Nuclear | Water | Other | Total |
|---|---|---|---|---|---|---|---|
| 1970 | 704 | 184 | 373 | 22 | 248 | 1 | 1,532 |
| %[a] | 46 | 12 | 24 | 1 | 16 | - | 100 |
| 1971 | 713 | 220 | 374 | 38 | 266 | 1 | 1,613 |
| % | 44 | 14 | 23 | 2 | 16 | - | 100 |
| 1972 | 771 | 274 | 376 | 54 | 273 | 2 | 1,750 |
| % | 44 | 16 | 21 | 3 | 16 | - | 100 |
| 1973 | 848 | 314 | 341 | 83 | 272 | 3 | 1,861 |
| % | 46 | 17 | 18 | 4 | 15 | - | 100 |
| 1974 | 828 | 301 | 320 | 114 | 301 | 3 | 1,867 |
| % | 44 | 16 | 17 | 6 | 16 | - | 100 |
| 1975 | 853 | 289 | 300 | 173 | 300 | 4 | 1,918 |
| % | 44 | 15 | 16 | 9 | 16 | - | 100 |
| 1976 | 944 | 320 | 295 | 191 | 284 | 4 | 2,038 |
| % | 46 | 16 | 14 | 9 | 14 | - | 100 |
| 1977 | 985 | 358 | 306 | 251 | 220 | 3 | 2,124 |
| % | 46 | 17 | 14 | 12 | 10 | - | 100 |
| 1978 | 976 | 365 | 305 | 276 | 280 | 4 | 2,206 |
| % | 44 | 17 | 14 | 13 | 13 | - | 100 |
| 1979 | 1075 | 304 | 329 | 255 | 280 | 6 | 2,247 |
| % | 48 | 14 | 15 | 11 | 12 | - | 100 |
| 1980 | 1162 | 246 | 346 | 251 | 276 | 6 | 2,286 |
| % | 51 | 11 | 15 | 11 | 12 | - | 100 |
| 1981 | 1203 | 206 | 346 | 273 | 261 | 6 | 2,295 |
| % | 52 | 9 | 15 | 12 | 11 | - | 100 |
| 1982 | 1193 | 147 | 305 | 283 | 309 | 5 | 2,242 |
| % | 53 | 6 | 14 | 13 | 14 | - | 100 |

[a]Percentage calculated by GAO.

Source: Developed from DOE's Energy Information Administration data, November 1982.

As table 8 shows, total annual electricity production increased by 710 billion KWHs in 1982 over 1970's level. Increased use of coal (489 billion KWHs) and nuclear power (261 billion KWHs) accounts for nearly all the increased production.

The 1,300 percent increase in nuclear production and its increasing share of production--from 1 percent of production in 1970 to about 13 percent in 1982--are due to the addition of substantial amounts of nuclear capacity during the 1970's.

## TRENDS IN POWERPLANT PERFORMANCE

According to NERC, analyzing the performance of electric generating powerplants is complicated because no single index can comprehensively represent the total performance of a single unit or group of units. NERC believes several performance indexes should be considered in measuring the capabilities of electric powerplants. As discussed below, each of the primary performance indexes currently used by the electric generating industry identifies a specific aspect of a unit's performance: capacity factor, operating availability, equivalent availability factor, output factor, and forced outage rate.

### Capacity factors are declining

Our analysis of the data published for these performance indexes for the period 1970 to 1980 indicates that the performance of the Nation's powerplants declined somewhat. However, it is not possible to quantify the extent of the decline due to the limitations of the data.

Probably the most visible trend in powerplant performance during the 1970's was the steady decline in average powerplant capacity factors, according to a recent DOE report. Capacity factor is the ratio of the total actual generation of a powerplant to the nameplate capacity of the powerplant for a given time period, in this case 1 year. For example, if a plant has a 65 percent capacity factor for the year 1981, it produced 65 percent of the electricity that it could have produced if it had been operating all year at its maximum dependable capacity.

As shown in table 9, from 1970 to 1981, average powerplant capacity factors declined from 67.8 to 63.4 percent for baseload (as defined by DOE) plants[5] and from 55.3 to 45.4 percent for all plants.

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[5]Baseload powerplants are normally operated at a constant high level of their capacity--ideally, at their maximum dependable capacity. Cycling plants are normally operated at varying levels of their capacity as the demand on the system varies. Peaking plants are generally operated only to meet peak demand.

Table 9

Average Powerplant Capacity Factors by Load Category, National, 1970-1981 (Percent)

| Category | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Base[b] | 67.8 | 67.3 | 67.1 | 65.2 | 65.5 | 64.2 | 64.5 | 63.6 | 63.7 | 64.1 | 64.4 | 63.4 |
| Cycle 2[c] | 41.7 | 43.2 | 42.4 | 42.8 | 43.0 | 42.2 | 43.0 | 41.9 | 43.0 | 43.0 | 41.8 | 42.2 |
| Cycle 1[d] | 25.6 | 26.0 | 26.0 | 25.8 | 26.6 | 25.9 | 26.4 | 26.3 | 25.5 | 25.5 | 26.1 | 25.7 |
| Peak[e] | 8.0 | 8.4 | 9.2 | 7.9 | 8.2 | 5.6 | 5.9 | 6.5 | 6.2 | 9.9 | 6.1 | 5.0 |
| All plants | 55.3 | 54.1 | 53.6 | 52.2 | 48.6 | 46.6 | 47.3 | 47.2 | 47.4 | 47.2 | 46.8 | 45.4 |

[a]1981 data are preliminary.

[b]Capacity factor equal to or greater than 50 percent.

[c]Capacity factor equal to or greater than 33 percent and less than 50 percent.

[d]Capacity factor equal to or greater than 17 percent and less than 33 percent.

[e]Capacity factor greater than 0 and less than 17 percent.

Source: DOE - Capacity Utilization and Fuel Consumption in the Electric Power Industry, 1970-1981, p. 35.

This decline in capacity factors should not be interpreted to mean that the efficiency of U.S. powerplants is declining in similar proportions. Most of the decline in capacity factors is due to increases in capacity supply and the way utilities have chosen to operate the powerplants in their generation systems, not the technical efficiency of the plants themselves. A number of developments occurred in the 1970's whereby utilities, in order to operate their powerplants most economically, often did not operate their system most efficiently in terms of capacity factors, heat rates,[6] and other traditional efficiency measures. Some of the more significant developments were that

--capacity increased faster than demand, resulting in larger reserve margins;

--oil prices increased over 700 percent, prompting utilities to use less expensive fuels to generate electricity, especially after the 1978 oil price increases; and

[6]Heat rate of a powerplant is the British thermal units (Btu's) of fuel needed to produce a kilowatthour of electricity.

APPENDIX VI

--baseload oil and coal plants were displaced by the addition of substantial amounts of baseload nuclear plants which are less expensive to operate but have lower average capacity factors because if shut down they are usually down for longer periods of time.

Capacity has increased more than demand

With two minor exceptions (1975 and 1978), growth in generating capacity (supply) has been greater than growth in the amount of electricity generated (demand) by the Nation's utilities for each year from 1970 to 1981. Capacity for the 12-year period increased by 87 percent, as shown in table 10, while total generation demand increased only by 50 percent.

Table 10

Annual Growth Rates in Generation and Capacity

| Category | 70-71 | 71-72 | 72-73 | 73-74 | 74-75 | 75-76 | 76-77 | 77-78 | 78-79 | 79-80 | 80-81 | Total growth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capacity | | | | | | | | | | | | |
| Growth (%) | 8.1 | 9.1 | 10.6 | 7.7 | 7.0 | 4.4 | 4.8 | 3.7 | 3.2 | 2.7 | 3.6 | |
| Total-Beg/end[a] | | | | | | | | | | | | |
| (GW) | 320.0 | | | | | | | | | | 599.9 | +87% |
| Generation | | | | | | | | | | | | |
| Growth(%) | 5.3 | 8.5 | 6.3 | 0.4 | 2.7 | 6.3 | 4.3 | 3.9 | 1.9 | 1.7 | 0.3 | |
| Total-Beg/end | | | | | | | | | | | | |
| (billion kWh) | 1532 | | | | | | | | | | 2,293 | +50% |

[a]Beg/end represents the total for 1970 (beginning) and the total for 1981 (ending).

Source: "Capacity Utilization and Fuel Consumption in the Electric Power Industry," Energy Information Administration, DOE/EIA-0343.

As a result, the planned summer reserves for the Nation's electric generating system had climbed to about 32 percent by 1981 (winter reserves are somewhat higher), compared to the 20 percent reserve margin which the industry considers "adequate." Since there was more capacity (supply) available in 1981 to meet demand, it is reasonable to expect that the average powerplant in 1981 would be used less than the average plant in 1970. This expectation is reflected in the declining average capacity factors for all plants.

Oil prices increased

According to DOE's 1982 Annual Energy Review, crude oil prices increased from $3.40 per barrel in 1970 to $31.93 per barrel in 1982--over 830 percent. Prices of residual fuel oil, which is used in oil-fired generating plants, also increased sharply. As a result, the cost of generating electricity from oil-fired plants escalated, and utilities reacted by

substituting lower cost generation--primarily coal-fired generation--whenever possible and increasingly using their oil plants in cycling mode, operating at less than full capacity to meet short-term demand.

Also during the 1970's, new baseload nuclear plants were added to the Nation's capacity, and their share of total generation increased from 1 percent in 1970 to 13 percent in 1982. While nuclear power was cheaper to provide than oil-fired generation, the 1971-80 average capacity factor for nuclear plants reported by NERC was 59.8 percent. This is 1 to 3 percent lower than the capacity factors being reported for all oil plants 200 MWs and over prior to the 1973 oil price increases. Oil plants being used only as baseload plants probably had even higher capacity factors.

In any event, the increasing use of oil plants as cycling units and the substitution of lower capacity-factor nuclear plants for baseload oil plants both had an impact on lowering average capacity factors. Rising oil prices helped provide impetus to these two situations.

AVAILABILITY OF POWERPLANTS IS DECREASING

Availability is another traditional measure of powerplant performance. The two most common availability indexes are operating availability factor (AF) and equivalent availability factor (EAF).

NERC defines the availability factor as the percentage of time a unit is capable of producing power at some level over some time period. Simply stated, it is the percentage of time a unit is available to produce power, not necessarily at its maximum capacity, but at any capacity.

The equivalent availability factor is similar to the AF but includes an adjustment for the effect of deratings (losses in capability) due to partial forced and scheduled outages. Therefore, EAF is the equivalent percentage of time during which a unit was available for operation at dependable capacity.

The only powerplant availability data we identified during our review were contained in reports prepared by NERC from its Generating Availability Data System. The performance indexes in these availability reports were calculated from samples of the 2,634 units for which utility companies voluntarily submit data to the Generating Availability Data System. The samples are not randomly chosen on a statistical basis but are simply the number of units out of the total that are in the particular fuel type and size categories for which NERC calculates performance indexes. We noted that some of the NERC samples were limited when compared to the total number of generating units obtained

from DOE's July 1982 inventory of powerplants. As mentioned earlier, there are over 10,000 generating units nationwide but only 2,634 units in the Generating Availability Data System's data-base. The NERC samples and DOE inventory for coal and oil plants over 200 MWs and for all nuclear plants are shown in table 11.

Table 11

| Fuel type | 1980 NERC samples | December 1981 DOE inventory |
|---|---|---|
| Coal (200MWs+) | 309 | 424 |
| Oil (200MWs+) | 99 | 157 |
| Nuclear (all) | 60 | 76 |
| Total | 468 | 657 |

Despite the time discrepancy between the NERC and DOE data, we believe the above comparison is valid since few new units began operations in 1981. Therefore, the availability data generated by NERC do not necessarily reflect the availability of all powerplants in the U.S. inventory, and NERC does not claim that they do. Table 12 was prepared from NERC's availability data:

Table 12

Powerplant Availability Indexes, 1970-1980

| Plant type | Performance measure | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1971-80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal | | | | | | | | | | | | | |
| 200-574 MWs | AF | 83.3 | 83.9 | 81.3 | 82.3 | 80.5 | 77.5 | 76.8 | 77.6 | 78.5 | 77.8 | 78.9 | 79.4 |
| | EAF | 81.0 | 81.4 | 76.8 | 78.8 | 75.8 | 72.6 | 70.9 | 71.8 | 72.3 | 71.8 | 73.3 | 74.3 |
| | FOR | 6.7 | 8.1 | 9.5 | 8.5 | 11.0 | 12.2 | 11.2 | 11.6 | 10.8 | 11.3 | 10.0 | 10.5 |
| | EFOR | 8.8 | 10.7 | 14.1 | 12.2 | 16.1 | 17.5 | 18.1 | 17.8 | 17.8 | 17.8 | 16.0 | 15.9 |
| | SOR | 10.7 | 10.0 | 11.3 | 10.9 | 11.2 | 13.0 | 14.3 | 13.9 | 13.5 | 13.0 | 12.9 | 12.5 |
| | Sample # | 151 | 160 | 171 | 164 | 182 | 190 | 192 | 166 | 193 | 206 | 224 | 258 |
| 575 MWs+ | AF | 70.2 | 75.6 | 75.3 | 78.0 | 74.9 | 74.2 | 73.3 | 71.1 | 73.4 | 74.8 | 75.8 | 74.6 |
| | EAF | 63.2 | 69.3 | 69.2 | 73.1 | 67.8 | 66.1 | 66.2 | 65.1 | 65.5 | 67.6 | 70.1 | 67.8 |
| | FOR | 19.2 | 16.1 | 14.0 | 14.6 | 16.9 | 14.8 | 15.2 | 17.1 | 16.5 | 14.3 | 12.1 | 15.0 |
| | EFOR | 26.3 | 22.7 | 19.8 | 20.0 | 24.7 | 23.9 | 22.7 | 23.6 | 25.1 | 22.2 | 18.4 | 22.3 |
| | SOR | 13.2 | 11.2 | 14.1 | 11.6 | 12.8 | 13.6 | 15.3 | 15.7 | 12.5 | 13.6 | 14.2 | 13.6 |
| | Sample # | 26 | 31 | 43 | 55 | 64 | 70 | 74 | 55 | 67 | 74 | 85 | 97 |
| Oil | | | | | | | | | | | | | |
| 200-574 MWs | AF | 84.2 | 86.8 | 84.9 | 82.3 | 82.7 | 80.3 | 79.8 | 81.3 | 80.9 | 80.0 | 81.3 | 81.8 |
| | EAF | 81.7 | 83.5 | 82.4 | 77.9 | 78.8 | 76.0 | 75.1 | 76.3 | 76.4 | 74.5 | 75.5 | 77.4 |
| | FOR | 4.5 | 3.9 | 5.6 | 8.3 | 8.3 | 7.4 | 7.4 | 8.1 | 8.0 | 10.9 | 8.1 | 7.7 |
| | EFOR | 6.3 | 6.9 | 7.7 | 12.7 | 12.4 | 12.1 | 12.7 | 13.3 | 12.9 | 16.3 | 14.3 | 12.2 |
| | SOR | 11.8 | 10.1 | 11.8 | 12.3 | 11.0 | 16.3 | 16.5 | 12.4 | 12.8 | 12.8 | 13.0 | 13.1 |
| | Sample # | 67 | 68 | 77 | 60 | 83 | 88 | 101 | 78 | 93 | 94 | 82 | 150 |
| 575 MWs+ | AF | 83.6 | 81.6 | 83.0 | 73.0 | 82.6 | 75.7 | 72.1 | 75.0 | 76.4 | 74.5 | 78.9 | 76.5 |
| | EAF | 80.4 | 79.9 | 79.6 | 63.2 | 75.0 | 68.8 | 66.4 | 69.3 | 70.8 | 68.0 | 73.4 | 70.6 |
| | FOR | 3.3 | 10.0 | 5.4 | 15.8 | 8.7 | 14.1 | 7.7 | 13.3 | 8.6 | 15.7 | 8.6 | 11.0 |
| | EFOR | 5.8 | 11.4 | 6.9 | 26.2 | 18.2 | 21.9 | 15.3 | 20.1 | 15.4 | 23.5 | 16.3 | 18.0 |
| | SOR | 13.5 | 9.4 | 14.3 | 14.5 | 11.3 | 14.6 | 24.1 | 17.1 | 17.8 | 15.6 | 17.3 | 16.6 |
| | Sample # | 4 | 6 | 7 | 5 | 8 | 12 | 14 | 20 | 19 | 18 | 17 | 28 |
| Nuclear | | | | | | | | | | | | | |
| All plants | AF | 84.8 | 79.2 | 79.6 | 80.7 | 68.0 | 73.4 | 70.2 | 74.2 | 78.3 | 68.2 | 68.8 | 72.4 |
| | EAF | 82.5 | 71.6 | 73.7 | 74.4 | 64.0 | 66.7 | 65.6 | 69.8 | 74.3 | 64.8 | 64.5 | 67.8 |
| | FOR | 2.9 | 7.4 | 6.4 | 10.3 | 18.2 | 16.0 | 15.2 | 9.4 | 8.4 | 16.4 | 11.2 | 12.8 |
| | EFOR | 5.2 | 16.6 | 10.3 | 15.6 | 22.3 | 22.6 | 19.7 | 14.5 | 12.4 | 20.0 | 16.1 | 17.6 |
| | SOR | 12.6 | 15.3 | 17.5 | 12.4 | 17.6 | 16.4 | 22.6 | 20.4 | 17.3 | 19.2 | 23.2 | 19.2 |
| | Sample # | 9 | 11 | 11 | 22 | 42 | 49 | 53 | 57 | 53 | 63 | 60 | 69 |

Key for performance measures:

AF--Operating availability factor.
EAF--Equivalent availability factor.
FOR--Forced outage rate is the percent of time a unit is unable to operate when required for service because of equipment failure.
EFOR--Equivalent forced outage rate is the rate that a unit is forced out of service considering full and potential outages and is expressed as an equivalent rate of full outage at gross maximum capacity.
SOR--Scheduled outage rate is the percent of time a unit is unable to operate due to a scheduled maintenance or inspection shutdown.
Source: Compiled from NERC's "Ten Year Review - 1970-1979 Report on Equipment Availability" and "Ten Year Review - 1971-1980 Report on Equipment Availability."

Analysis of NERC's availability data showed that there was a slight downward trend in both AF and EAF for all the plant categories listed. We can make the following general observations about the NERC data:

--There was a slight downward trend as evidenced by the fact that AF in the last 6 years exceeded the 11-year average only 20 percent of the time and EAF only 17 percent.

--The downward trend may be more serious than the percentages show because in recent years more plants are used to compute both AF and EAF.

--The decline in EAF was greater than the decline in AF, which could indicate an increase in partial outages.

--The greatest declines in AF and EAF were reported in coal plants of 200-574 MW size and oil plants of over 575 MW.

By definition, the declines in AF and EAF resulted from increases in the various outage rates and this can be observed in the NERC data. The reasons for outages were many, and NERC published a report which cited the various reasons why specific plants were shut down. The reasons were not summarized and it would be time consuming to identify trends from these reports.

Although NERC data show some decline in the availability of U.S. powerplants, it would be inadvisable to draw conclusions about the magnitude of the problem because of the limitations in the data discussed earlier.

Other studies on powerplant productivity

Two reports published in 1982 addressed the performance of fossil-fueled powerplants, one by the National Economic Research Associates, Inc. (National Associates), and the other by DOE.

National Associates traced the performance--measured by EAF and annual heat rate--over the period from 1970 to 1977 of a sample of coal units built before 1970. The report found that the EAF for its sample declined from 76 percent in 1969 to 64 percent in 1977--an average decline of 1.5 percent per year. Also, heat rates for these plants rose from 9,070 to 9,600. Therefore, not only were the sample units becoming less available, but they were requiring more fuel to generate each kilowatthour. National Associates found that older plants or aging plants were not the primary explanation for the declining powerplant performance. What was observed was that poor powerplant performance follows as utility earnings are reduced and reduced earnings restrict management options. National Associates found that the utility industry could halt the declining performance

trends by replacing obsolete or defective equipment, adding equipment to compensate for low quality fuel, and increasing maintenance expenditures--activities that are difficult when earnings are low.

The DOE study took existing 1982 coal, oil, and gas-fueled installed generating capability and focused on potential reduction in this capability in 1987 and 1992 due to the net effect of (1) declining generating unit performance and (2) increases in performance due to powerplant productivity improvements. Future declining unit performance was projected into the future for various powerplant categories by using historical performance trends.

DOE found that by 1987 about 6,700 MWs of 1982's capacity will be unavailable, and by 1992 about 14,000 MWs will be unavailable due to declining performance. The total existing 1982 capability is about 583,000 MWs. However, these losses could be reduced to about 3,000 MWs in 1987 and 9,400 MWs in 1992 by introducing improvement programs designed to reduce forced outage rates of 400+ MWs coal and nuclear units by 10 percent. Productivity improvement programs could include improvements in administrative controls (e.g., preventive maintenance management, forced outage avoidance strategies) or improvements in physical plant, such as improved plant design to increase efficiency and facilitate maintenance.

These studies seem to validate the idea that powerplant productivity is declining and shed light on the difficult balance which must be addressed in developing a "least-cost strategy" which includes an optimum level of investment in maintenance of plant, rehabilitation, and new plant. However, because of their limited scope, we believe that these reports are also inconclusive as to quantifying the magnitude of declining powerplant performance for the Nation's powerplant inventory as a whole.

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