Potential for ENERGY CONSERVATION in the United States: 1974-1978

A Report of the National Petroleum Council

ELECTRIC UTILITY

PHOTOGRAPHS COURTESY OF

Ashland Oil, Inc.

Koppers Co., Inc.

U.S. Steel

Pacific Lighting Corp.

POTENTIAL FOR ENERGY CONSERVATION
IN THE
UNITED STATES: 1974-1978
ELECTRIC UTILITY

A Report of the

National Petroleum Council

Maurice F. Granville, Chairman
Committee on Energy Conservation

Robert C. McCay, Chairman
Coordinating Subcommittee
of
Committee on Energy Conservation

Thomas H. Burbank, Chairman
Electric Utility Task Group
of
Committee on Energy Conservation

September 10, 1974

NATIONAL PETROLEUM COUNCIL

Industry Advisory Council
to the

U.S. DEPARTMENT OF THE INTERIOR

Library of Congress Catalog Card Number: 74-79107

Printed in the United States of America

PREFACE

The Electric Utility Task Group was organized under the National Petroleum Council's Committee on Energy Conservation in November 1973. In response to the charge of the Coordinating Subcommittee, based upon the study request letter from the Secretary of the Interior (see Appendix A), the Electric Utility Task Group has prepared an appraisal of the short-term 1974-1978 energy conservation measures applicable to the electric utility industry. This report represents the detailed work which served as the basis for Chapter Five, "Electric Utility," of the National Petroleum Council's report, *PotentiaZ for Energy Conservation in the United States: 1974-1978*, published on September 10, 1974.

This appraisal of energy conservation potential in the electric utility industry is confined to the generation and distribution aspects of the electric utility industry. Although the Task Group's assignment was limited to conservation measures possible in the generation and distribution of electric energy, a discussion of how utility company programs could stimulate consumer conservation was considered essential in the context of the overall study. A brief discussion of this subject appears in Appendix C. (The main discussion of consumer-oriented conservation measures is contained in the Residential/Commercial Task Group Report.) This work was developed concentrating on the methods of energy conservation that are feasible within the present physical, political, regulatory and social constraints imposed upon the industry.

The results of the analysis show that the industry is comparatively efficient within current thermodynamic limitations and that the potential savings achievable by 1978 are relatively small compared to other major end-use sectors. The report has attempted to identify measures and realistic opportunities for the overall conservation of fuel during the 1974-1978 period. It has also attempted to identify those measures which could specifically result in the saving of oil. Long-term considerations will be addressed in the report on Phase 11--1979-1985.

TABLE OF CONTENTS

INTRODUCTION

STRUCTURE OF THE ELECTRIC UTILITY INDUSTRY

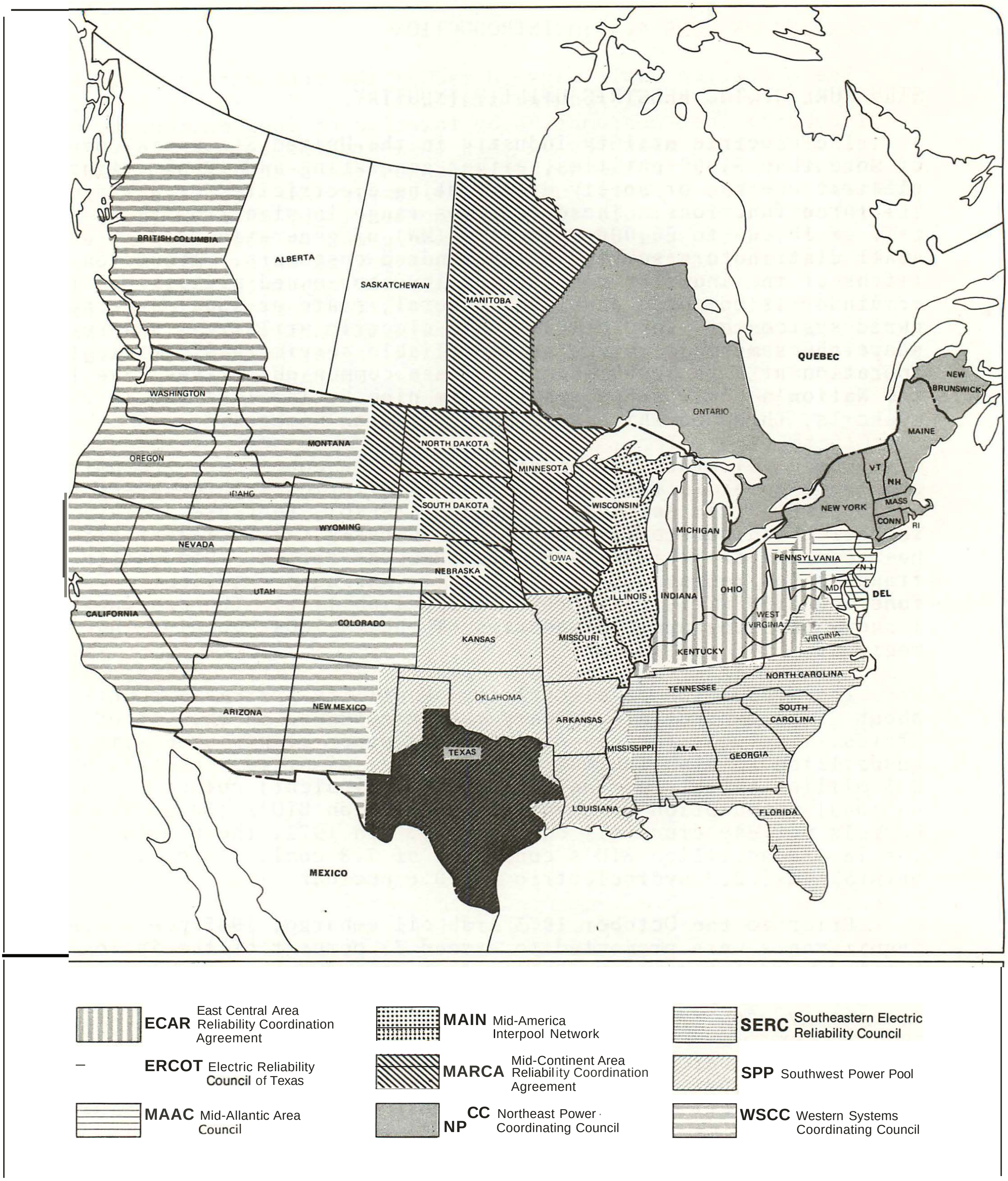
The electric utility industry in the United States is comprised of more than 3,000 entities, either generating and transmitting electric energy, or solely distributing electricity, or performing all three functions. These entities range in size from large systems of 10,000 to 20,000 megawatts (MW) of generating capacity to small distributors serving a few hundred customers. About four-fifths of the industry consists of investor-owned utilities. The remainder is composed of either federal, state or local government owned systems or cooperatives. All electric utilities, however, share the same major concerns of reliable service and efficient operation at a reasonable cost. These common objectives have led the Nation's power suppliers to form nine Regional Reliability Councils, three of which also have Canadian members.

These voluntary organizations serve to coordinate the bulk supply of power in their respective territories. Through the National Electric Reliability Council (NERC), they are striving to further coordinate on a North American basis. This latter effort has been underway since 1968 when NERC was formed. Generation and transmission reliability traditionally has been excellent. One function of NERC is to improve this reliability. The map in Figure 1 shows the geographic boundaries of the various coordinating regions.

The production of electricity by utility systems accounts for about 25 percent of all primary energy consumed in the United States. In 1972, for example, utility power plants used some 18.5 quadrillion British Thermal Units (BTU's) of primary energy (about 8.5 million barrels per day crude oil equivalent) out of a total national consumption of about 72 quadrillion BTU's (34.5 million barrels per day crude oil equivalent). In 1972, the breakdown of the 18.5 quadrillion BTU's consisted of 7.8 coal, 3.1 oil, 4.1 natural gas, 2.9 hydroelectric and 0.6 nuclear.

Prior to the October 1973 Arab oil embargo, 1985 power plant requirements were projected to exceed 35 percent of the Nation's total demand for primary fuels. As a consequence, the electric utility industry would be the largest single consuming sector in the energy economy.

About 85 percent of the total electric utility industry's primary energy supply is of domestic origin; however, in some areas of the country, particularly the Northeast and Southern California, more than half of all fuel supplied to power plants is in the form of imported fuel oil. Most projections made prior to October 1973, estimated that the overall industry's mix of domestic and foreign fuel would remain at about 85/15, respectively, through 1985. Since oil is the only imported fuel of any significance, the electric utility industry's requirement for oil is now its main direct exposure to fuel shortages created by actions outside the control of the United States.



SOURCE: National Electric Reliability Council

Figure 1. National Electric Reliability Council Coordinating Regions.

THE MEANING OF CONSERVATION

There are two basic ways to reduce the consumption of fuel so that demand will equal reduced availability. One way is to directly discourage fuel consumption by taxation or fuel rationing. Examples of extreme measures of this type are the recent prohibition of Sunday driving in the Netherlands and the practice of "load curtailment" in the electric utility systems. (Also see Appendix C.) The second way to reduce fuel consumption is by encouraging improved efficiency in the use of fuels. Improvement in the efficiency of generating and distributing electric power is an example of such a measure. It is not possible to completely separate these two types of conservation measures. Higher fuel prices or taxes which primarily discourage fuel consumption may indirectly stimulate the adoption of more efficient use of fuels; nevertheless, it is useful to consider these two types of measures separately, on the basis of the differences in their primary effects.

In the short term, there may be shortages of fuel so that it might be necessary to adopt measures to discourage or prohibit fuel consumption in order to manage the shortfalls. The principle effect of a measure such as electrical load curtailment is to distribute the effects of a fuel shortage. In the long term, it will probably be necessary to exert a substantial effort to improve the efficiency of fuel utilization. In fact, in the context of conservation, measures to improve fuel utilization are more desirable than straightforward curtailment of fuel use, since the principal effect of fuel curtailment measures,when they can be adopted, is simply to distribute an existing fuel shortage, rather than to relieve the demand for natural resources. If conservation of fuels were to be implemented solely through mandatory reduction of fuel consumption, it would lead to substantial alterations in the national economy and the national style of life.

FUEL SHORTAGES *VERSUS* ENERGY SHORTAGES

Currently, the United States is suffering from a shortage of particular fuels, i.e., energy in the forms necessary for use by ultimate consumers in specific applications. The reasons for this shortage are many, but they are not the result of an absolute penury of raw energy sources within our national boundaries. While 7S percent of present U.S. energy consumption is in the form of oil and gas, of which some 20 percent is currently being imported, more than 90 percent of the Nation's proven energy reserves extractable with proven technology are in coal and uranium.

Conservation of energy has become an important facet of national policy. All forms of energy, however, do not have equivalent conservation values since their resource availabilities, their use costs, and their efficiencies during use may differ quite markedly. Although market prices, over the long run, should appropriately reflect all of these differences among fuels, it has been questioned whether regulation has allowed the market price system to reflect both value and cost. From another point of view, there is some doubt as to whether the externalities have been, or even could be, included in the price. In the current era of concern for adequate supply of energy, the ethic of conservation of any and all BTU's may lead to a disregard of these differences.

In designing generating stations, the choice of operating a nuclear unit, with a lower BTU efficiency, for an oil-fired unit is quite clear. Not only would this choice conserve scarce oil BTU's, but it would also use the currently lower-cost nuclear fuel. The case is much less evident when it is extended to the end-use. For example, it has been pointed out that residential consumers who reduce their use of electric energy for lighting and appliances in the winter would have to increase somewhat their use of energy for heating their residences. If the source of electric energy is coal and the furnace is oil-fired, then they have caused a partial substitution of oil for coal. Even if the oil-fired furnace conversion efficiency for heat is better than the generating station's heat rate, the BTU's conserved by the utility are less scarce.

When secondary and tertiary impacts are considered, the tTade-offs become very difficult to quantify. For example, if a utility shifts from an existing supply of natural gas to a new supply of distant coal, there are many related energy impacts beyond the direct scarcities and burning efficiencies of the two fuels. Fuel must be used to transport the coal, fuel must be used to construct the transportation equipment, to mine the coal, etc. The continued use of natural gas in the utility boiler with other consumers shifting to coal or oil might be more efficient or desirable from a total economy, and even from an energy economy point of view.

With these facts in mind, the Electric Utility Task Group has organized its short-term study into two parts. The first part focuses/ attention on possibilities for near-term absolute savings in energy consumed in the production of electricity; the second part looks at the particular potential for reducing oil consumption in power plants--a conservation strategy not necessarily associated with total energy-use curtailment.

SUMMARY OF SHORT-TERM CONSERVATION POTENTIALS

No change in fuel use to conserve oil, gas or other forms of energy can be effected without some costs to the consumer, either indirectly through higher monetary costs or directly through reduced comfort, convenience or freedom to consume.

Assuming that short-term energy conservation goals will emphasize the conservation of oil and gas, the following is a list of potential conservation measures:

- Greater efforts should be directed toward expediting the completion of nuclear generating units under construction and assuring their safe, full-power operation.

  --The areas in the eastern United States most critically affected by the uncertain availability of oil imports have heavy commitments to new nuclear units.

  --The electrical energy produced by nuclear or coal plants, operating on base load, would displace the annual requirement of approximately 10 million barrels of oil for each 1,000 MW of generating capacity.

- To assure long-term supplies of domestically produced, low-sulfur fuel, legislative problems concerning strip mine reclamation should be resolved as soon as possible so that the mining of near-surface coal can be expanded.

- The rate of implementation of air quality regulations might be modified to permit the intermittent burning of more high-sulfur coal because such coal is more readily available in the quantities needed.* This change should be feasible without sacrificing essential air quality goals through the judicious use of intermittent emission control measures. (Variances should be extended for a period long enough to provide incentives to develop low-sulfur coal supplies and/or to permit development of clean fuel from coal through research.)

- Where the use of residual fuel oil is necessary, consideration should be given to postponing the implementation of strict sulfur level limits in order to give utilities a wider range of fuel oil options. This would tend to ease overall strains on the low-sulfur residual fuel market and provide savings in energy required for desulfurization.

---

* This report merely states the facts regarding the interrelationship between environmental control and energy conservation; it does not take positions on ecological goals.

- Voltage reductions should be used as emergency means for conserving scarce distillates during peak periods by electric utilities consuming such fuels.

- Greater interregional transfers of surplus power produced by coal, nuclear, or hydro energy should be encouraged whenever such energy can displace the use of oil or gas for electricity production. Planned interconnections which could facilitate the movement of major blocks of energy out of areas with plentiful coal supplies might be expedited.

- Planned service curtailments should not be used as conservation measures but should be reserved for use in emergency situations when fuel supplies have fallen to a critically low level.

Quantitative estimates of potential short-term savings in the production and distribution of electricity must be stated with caution because of the many corporate and government decisions that could affect the realization of these savings. However, under the best possible circumstances, it would appear that the total energy savings which might be achievable by 1978 would approximate 5 percent of 1978 primary energy consumed by the electric utility industry. If conservation efforts were focused only on petroleum products, and if all coal/oil convertible capacity which is now using oil were switched to coal, the annual oil savings achievable by 1978 might represent nearly 50 percent of the oil used by electric utilities in 1972. The quantitative estimates are summarized in Table 1 with the caveat that the potential savings volumes are not necessarily additive because one conservation action might affect another.

TABLE 1

POTENTIAL ENERGY.SAVINGS BY ELECTRIC UTILITY SYSTEMS BY 1978.
{Thousand Barrels Per Day Oil Equivalent!

(Estimates are not additive) t

Category	1974 Shift from Oil	1974 Total Energy Savings	1978 Shift from Oil	1978 Total Energy Savings	Remarks
Load Management Shifts and Reductions	14	14	18§	18§	Assumes 1% shift in load from peak to off-peak. All savings assumed to be in oil used for peaking units.
Efficiency Dispatch	44	44	55 §	55 §	Savings in oil estimated at 0.5% of all energy use.
Voltage Reductions	20	20	25§	25§	Assuming reductions practiced every working day during peak periods and all savings are in oil-fired peaking generation.
Foregoing the employment of:					
Flue-Gas Desulfurization					
New Coal Units				80	For new coal units approximately *2/3* of savings estimated to be possible by 1980.
Conversions				35	For conversions approximately 7% of the 500 MB/D consumed if complete reconversion to coal were effected at convertible plants.
Closed-Cycle Cooling			55	380	These figures exclude those plants for which no physical alternative exists due to water supply limitations. Value for 1978 is midpoint of range of 186-570 MBID cited. Oil savings estimated to be 15% of total savings.
Limitation due to LOCA ("loss of coolant" accident) Regulations on Nuclear Plants			17	10	Additional total energy by lifting LOCA regulations estimated at 35 MB/D of which 50% would represent oil savings. Total energy savings estimated at 30% of the incremental nuclear energy due to non-use of less efficient fossil units.
Oil to Coal Conversions	160		500		1974 average based on maximum NPC estimates of conversions possible by end of 1974. See *Short-Term U.S. Petroleum Outlook - A Reappraisal,* NPC, February 26, 1974. Value for 1978 based on FPC Form 36 Data. This latter figure is an estimate of the maximum physical capability to use coal. Without the granting of variances on air pollution control regulations, the effective conversion potential for 1978 will be considerably less than 500 MB/D.
Intersystem 1ransfers of Energy	30-200	(3)-(20)	30-200	(3)-(20)	The Savings cannot be realized on a continuous basis. Transmission losses estimated at 10% of transferred energy.

·Other potential savings are possible from such measures as repowering of old steam units using CT exhaust heat. However, these savings cannot be accurately estimated. Some estimates are maximums which would require modification of existing government requlations.

tTotal electric utility energy and oil consumption in 1972 was **8,425** *M8/D* and **1,460** *M8/D,* respectively, based on 8ureau of Mines press release, "US Energy Use Up Nearly 5 Percent in 1973:' March 13, 1973. The possible energy savings and shifts from oil outlined in the above table are not always additive. If, for example, LOCA derates on nuclear plants are lifted, the amount of oil savings due to efficiency dispatch could be reduced.

§Savings for 1978 based on the assumption that primary energy requirements of the electric utility industry will increase by approximately 25 percent between 1974 and 1978. Conversion at 6 million BTU per barrel.

POTENTIAL FOR IMPROVING STEAM GENERATION EFFICIENCY

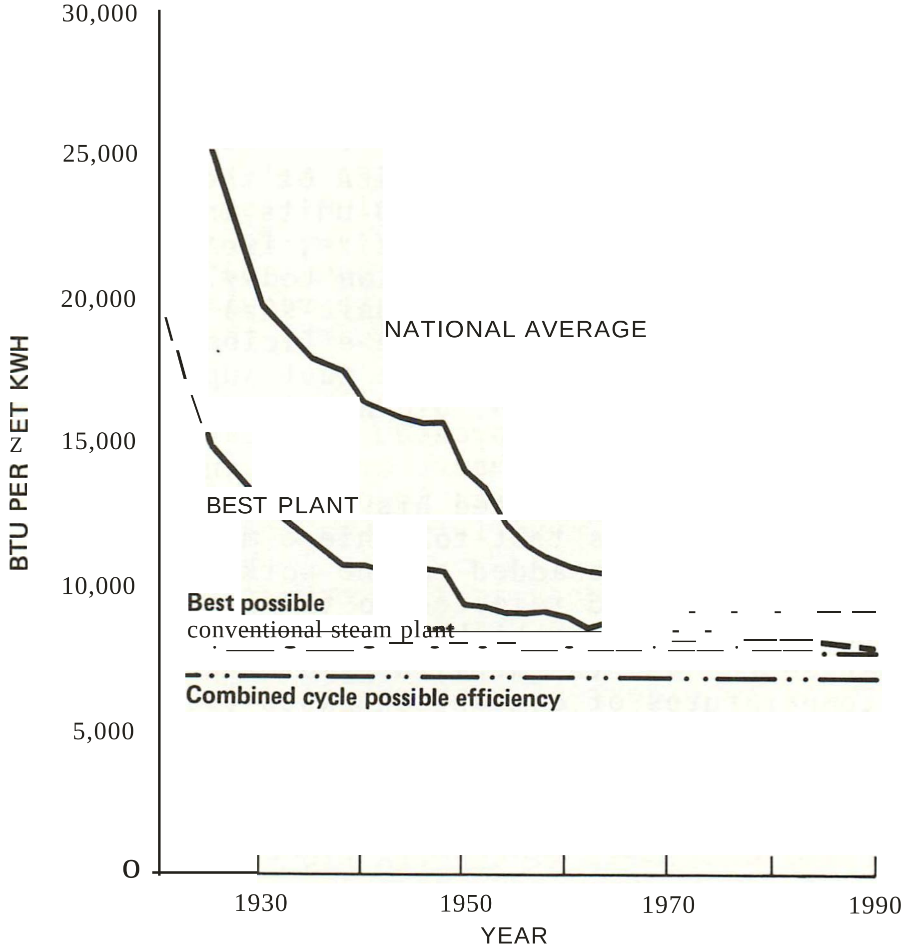
The most obvious characterization of the change that has occurred in stearn-electric generating units in the last few decades is the rapid increase in the unit size, from 200 MW in 1930 to over 1,300 MW for large units in operation today. Until the late 1950's, this rapid increase in generating unit size was accompanied by an equally dramatic improvement in the efficiency of converting heat energy into electrical energy. The fuel supplies consumed by the electric utility sector, then, did not increase as fast as did the production of electric energy.

In 1824, Carnot formulated his now famous Carnot Principle which effectively states that to achieve maximum thermodynamic efficiency, heat should be added to the working fluid at the highest possible temperature and rejected to the heat sink at the lowest possible temperature. The highest possible temperature is governed by the heat source and the metallurgy of the system. Because of the high temperatures of combustion gases (3,000°F), stearn temperatures of 1,000°F to 1,200°F have been utilized in fossil-fueled units, with superheat and reheat cycles, regenerative feedwater heaters, and super-critical boiler designs employed to minimize the inherent irreversibilities in the stearn cycle.

Present turbine material limitations prevent further significant increases in stearn temperatures of fossil-fueled plants. Because factors other than high temperature strength are overriding in nuclear reactor design, fuel and cladding temperature limitations restrict coolant temperatures in water-cooled nuclear reactors to about 650°F, which results in even lower steam temperatures. The best light water reactors have efficiencies of less than 35 percent compared to 41 percent for the best fossil-fuel units. Since fuel costs represent a much smaller fraction of the total energy costs from nuclear reactors, the increased capital costs associated with the additional feedwater heaters and larger heat exchangers needed to attain even small improvements in reactor efficiencies cannot be justified. Higher heat sink temperatures, resulting in a need for small cooling lakes, cooling towers and closed circulating water systems, further reduce the best attainable efficiency.

One measure of the energy conversion efficiency of an electric generating unit is its average "heat rate," or the amount of heat input in BTU's required to produce a net output of 1 kilowatt hour (KWH) of electrical energy. Figure 2 shows the marked decrease until 1960 in the best and the average generating unit heat rates.

In the last decade the energy conversion efficiency of the best fossil-fired generating units has improved only slightly, reflecting the attainment of a near optimal balance of capital and fuel costs. This optimum is the result of years of research and development (R&D) and a plethora of design optimization studies. An indication that the electric utility industry has approached an optimum design



NOTE: Based on chart of Federal Power Commission, *The 1970 National Power Survey, Part I*, Dec., 1971.

Figure 2. Heat Rates of Fossil-Fueled Stearn-Electric Plants.

based on current technology is the fact that the maximum stearn turbine throttle pressures and temperatures have recently declined. The relatively small gain in efficiency that was achieved by the highest temperature and pressure units was overshadowed by the increased capital and maintenance cost of installing and operating these units. Although the capital/fuel cost relationship may now be changing, the design of units scheduled for operation before 1978 is well advanced using current technology. Since design enhancement within the next 5 years is unlikely, efficiency improvements must be sought through improved operation of existing designs. The following are possible developments:

- The conversion of mechanical energy to electrical energy in the generator is necessarily accompanied by a certain amount of irreversible conversion of energy to heat. The value of maximum efficiency is largely a function of the amount of iron and copper used, and hence, is chosen from a balance of operating and capital costs. However, development of more efficient cooling methods may result in some increased efficiency in larger generators in the near term.

- While the steam cycle efficiency of light water nuclear reactors offers little potential for improvement, one short-term change that is expected to result in a much more efficient use of nuclear fuel is the advent of plutonium recycle. Plutonium is produced as a result of neutron capture by uranium-238 atoms in a typical reactor fuel loading. The recovery of this plutonium from the discharged spent fuel batch provides roughly one-fourth of the fissionable material needed for a subsequent batch of fuel. Additional capital outlays, however, are required to ensure that public safety is not compromised by the recycle of plutonium.

- Other improvements in the efficiency of generating stations might result from increased unit capacity ratings, if auxiliary power requirements are not increased proportionally. Locating multiple units in close proximity may also permit some sharing of auxiliary power equipment.

- Improved efficiency in the combustion process of fossil-fired boilers is accomplished by minimizing the amount of wasted heat. The largest heat loss results from a supply of air in excess of that required for complete combustion of the fuel. Efficient boiler operation demands the proper balance of air supply, with too much or too little resulting in fuel wastage. Automated boiler controls can provide efficiency improvements in this area. In addition, automated boiler controls, along with process-to-operator communications and increased sophistication in automated and manual system loading methods, can help to optimize operating conditions and minimize auxiliary power requirements.

- Improved metals and welding techniques will enable boilers to withstand higher temperatures and the erosion, corrosion, and abrasion problems associated with high velocity fuel/air mixtures and combustion products. Only a modest efficiency improvement can be expected from this source during the next few years.

- Finally, it may be possible to combine industrial plants requiring large amounts of process steam with utility electric generating units. Although the extraction of the steam before complete expansion in the turbine will lower the efficiency with which electricity is produced, the overall efficiency of fuel use may be increased. Similarly, industrial plants producing large amounts of excess steam (or gas) might be combined with utility generating facilities. In either instance, however, such combinations will entail less than optimum sizing of generating units and will pose many design and cost problems, so the short-term benefits from this possibility are not expected to be large.

LOAD MANAGEMENT SHIFTS AND REDUCTIONS

A utility has little direct control of the load shape resulting from its customers' requirements. Traditionally, special off-peak rates have been offered to divert energy demands to the off-peak period. Additional off-peak price reductions are unlikely to cause any rapid shift in loads. Mandatory shifts in customer loads would be very difficult to implement.

Shifts in loads from peak periods to off-peak periods enable the electric utility to achieve fuel savings in two ways. First, during peak periods, the least efficient generating units are brought into operation. If some of this load were shifted to off-peak periods, the more efficient units could be utilized to cover a larger proportion of the peak. Second, during low-load periods, some units of lesser efficiency must be operated merely to have them available to meet peak loads on the following day. Since some power is produced by these less efficient units during off-peak periods, generation from more efficient units is correspondingly reduced.

Based on very limited data, it has been estimated that a shift of 1 percent of the peak load to an off-peak period for all U.S. systems would result in a savings in oil equivalent to 5 million barrels per year (14 thousand barrels per day). However, it is uncertain whether customers would voluntarily shift that much load to off-peak periods.

Utilities, however, might be able to conserve energy by better control of the utilization of their generating resources to meet the customer's requirements. For example, it would be desirable to shut down small units now being maintained "on-line" during off-peak periods. Currently these units are being used off-peak either because they are needed within a small utility to carry load or because they would need modification to permit 8-hour economic shutdown. In the former case, shutdown could be accomplished by purchase of power from a neighboring large system which, because of larger units, might have a surplus of spinning reserve in the off-peak period. Based on very limited data in one region, the national savings might approach 6 million barrels of oil equivalent annually, were it possible to reach optimum operating scheduling. If necessary modifications were made to other units to enable them to be shut down for periods of 8 hours, it is estimated that an additional 5 million barrels of oil equivalent might be conserved annually. Such modifications, however, would require considerable time and capital investment, and probably, would not contribute much savings to the 1974-1978 period.

Planned Load Curtailment

One conceivable method of reducing energy consumption would be the deliberate denial of service to electric customers according to a definite pattern. Such measures are commonly referred to as planned load curtailment, rotating outages, or simply scheduled "blackouts." Most electric utilities have done the technical planning necessary for implementing these measures, but normally with a view to reducing peak loads during emergencies as opposed to conserving energy. In either case, detailed planning is a requirement not only for reasons of customer equity but to maintain the operating integrity of the system.

When used as an energy conservation technique, the curtailment of load poses certain problems such as the necessity of maintaining service to critical public facilities (i.e.,medical centers, police and fire stations, etc.), which are generally sited in the midst of commercial or residential customers. Disconnecting major sections of a distribution system will almost certainly involve curtailing some such facilities. Where this cannot be avoided, steps must be taken to assure that these essential functions are supplied by auxiliary generators.

Another problem associated with load curtailment is the constraint imposed by refrigerated food storage. Cutoffs of an excessive duration could result in the loss of considerable quantities of perishable foods which initially required energy to produce. Most curtailment plans have taken this factor into account by envisioning outages of less than 5 or 6 hours.

Another limitation of planned disconnections concerns the very nature of electricity consumption patterns. Some electrical loads may be classed as deferrable and others nondeferrable. Lighting is the classical example of a nondeferrable use. If electric service is not available one night to operate a lamp, the lamp will not be used twice as long the next night in order to make up for the lumens foregone the first night. Most electrical loads, however, are deferrable. This tends to attenuate over time the energy saving potential of load shedding. In a household, for example, a normal requirement for hot water exists and will probably be maintained regardless of power interruptions within reasonable limits.

Upon the initiation of a rolling outage scheme, many deferrable loads such as water heating would probably display the characteristics of nondeferrable loads. However, as customers become familiar with outage patterns, they are likely to reschedule a large proportion of their deferrable usage and as a result, actual KWH savings may diminish over time, until a steady state situation is obtained where most of the savings is represented by nondeferrable load. Although definitions of deferrable *versus* nondeferrable uses may not always be easily agreed upon, it would appear that in the residential sector, the bulk of KWH consumption would have to be considered deferrable. In commercial and industrial applications, nondeferrable KWH uses probably represent the greatest portion of the total. It is interesting to note, however, that in the United Kingdom during the coal miners strike of 1972, the use of planned load shedding revealed a surprising flexibility on the part of industrial customers who managed to reorganize themselves to make maximum use of the permitted hours of activity.*

An estimate of the ultimate extent of KWH savings possible from any reasonable program of curtailment would be extremely uncertain. Some order of magnitude calculations can be made. Assuming that,

---

* Brown, Sir Stanley, "How Britain Rationed Power," *Public Power* May-June 1972 .

at a maximum, customers could be disconnected on a rotating basis some 10 percent of the time and that most of the disconnection would take place during peak periods, the reduction in nondeferrable KWH load might only approximate 5 percent. Certain industrial customers such as continuous process industries would probably have to be excused from mandatory curtailment measures or special schedules arranged on a monthly or annual basis.

The actual percent savings of energy associated with such a drastic measure as planned load curtailment would probably exceed the percentage of total KWH conserved. This would be attributable to the displacement of deferrable consumption from peak periods to off-peak periods and to the dead loss of nondeferrable peak consumption. These additional savings resulting from reduced use of less efficient peaking plants might represent significant amounts of oil in the form of distillates. However, extreme measures such as these should be reserved for emergencies and, in any case, it must be stressed that the savings involved in utility operations would not be net savings for the economy as a whole. Attempts by customers to compensate for the mandatory curtailment could result in increased use of other energy sources--e.g., self-generation by industrial customers.

Another approach to the problem of load curtailment which avoids deliberate disconnection is the use of punitive fees or fines for customers who do not adhere to legislated conservation guidelines. An example of this technique is "The Emergency Energy Curtailment Plan" adopted by the Los Angeles City Council on December 21, 1973, after declaring an electrical energy emergency resulting from insufficient fuel supplies. This ordinance, since suspended, required residential and industrial customers to cut back electrical usage by 10 percent from a corresponding base period of the prior year. Commercial customers were required to cut back their electrical usage by 20 percent. A penalty of 50 percent of the total electrical bill was imposed on those customers not achieving the mandatory reduction quota.

The Los Angeles Department of Water and Power experienced a load reduction of approximately 17 percent below consumption for the base period. It has been estimated by the Department that over 10 of the 17 percentage points of reduction were attributable to the mandatory nature of their program.

Dispatching Procedure Changes Including Pumped Storage *Versus* Combustlon Turhlne Use

Nearly all electrical dispatch in the United States has been done purely on an economic basis. An exception is Southern California, where electrical dispatch has been done on a minimum NO_x basis since 1971, causing some increased fuel consumption. Using the inherent heat rates (efficiency) of each generating unit and cost of fuel then available for use in each unit, a central dispatcher searches the possibilities for adding electrical capacity and selects that capacity with the lowest marginal cost. The economic optimization calculation and subsequent dispatching can be done almost entirely by computer.

The current energy shortage has narrowed the consideration of economics to focus on efficiency of energy use but the additional criterion of minimizing oil usage would require that nuclear, hydro and coal generation capacity be used to the fullest extent possible. Efficiency dispatch has been calculated to reduce oil consumption by about 0.5 percent in the New England Power Exchange (NEPEX) region when compared to an economic dispatch. If this percentage were to be applied to the country as a whole, the equivalent of 16 million barrels of oil could be saved in 1974, or 44 thousand barrels daily.

Unfortunately, the current fuel supply situation does not permit simple efficiency dispatch. Gas turbines with heat rates as low as 12,500 BTU's per KWH are present in the generation mix of some systems. They would undoubtedly be run considerably more if efficiency were the only dispatch criteria, because on a number of systems, older fossil-steam units have much higher heat rates. However, gas turbines burn scarce No.2 oil and jet fuel which have competing uses, as in home heating and transportation. Since gas turbine units use these more expensive fuels, an economic optimization calculation would minimize their use. Superimposing restriction on the use of gas turbines under the efficiency mode of dispatch would revert back to essentially an economic mode of dispatch. This restriction would have the effect of eliminating nearly all of the savings attributable to shifting from economic to efficiency dispatch.

Pumped storage stations offer an alternative to the use of gas turbines given the right operating circumstances. For example, the New England region recently brought on-line a 1,000 MW pumped storage facility. Although the minimum design objective for this plant was an efficiency of 69 percent, it has been running at about 74 percent efficiency. In other words, approximately 1.35 KWH of pumping power during off-peak periods is required to produce 1 KWH of power during peak periods.

During the off-peak hours, units with heat rates of 10 thousand BTU's per KWH or less are available for pumping. As a result, units with heat rates of 13.5 thousand BTU's per KWH or more may be displaced during peak hours to provide a net savings in system energy. At present, the NEPEX pumped storage capacity is being heavily used as a consequence of both economic dispatch and the conservation of No.2 oil for higher priority uses. However, as the relative availability and expense of fossil fuels for the various base-load units changes, the underlying dispatch criteria may change.

Fuel Logistics

It is difficult to consider conservation effects through dispatching procedures without considering the logistics of fuel transportation and storage. Most system pools operate on an economic dispatching basis. Several studies have indicated that possible fuel conservation could result from using "BTU dispatching," that is, dispatching the system to utilize minimum BTU's even though the resulting system operating mode is not necessarily most economical. Most of these studies, however, have not taken into effect the BTU's expended in transportation of the fuels, and it is possible that any benefits to be gained through "BTU dispatching" could be lost in the inefficiencies of transportation, particularly where coal and oil are concerned.

As a rule, transportation means have been selected on the basis of economics, and this criterion has not always resulted in the most conservative energy usage. A comparison of the expenditures of energy for transporting each type of fuel may be the easiest way to organize a review of their overall BTU "cost" and to expose possible opportunities for fuel conservation through more effective use of the existing supplies.

Transportation energy used for moving nuclear fuels is negligible and opportunities for conservation can be considered insignificant. As for natural gas, the pipeline has been established as the most efficient means of transporting this fuel. While there is little opportunity to conserve transportation energy used for gas movement, the use of gas in locations which would minimize the alternative transportation requirements for coal and oil could make an effective contribution to BTU conservation. Insofar as coal is concerned, it is usually transported by railway or barge, or a combination of the two.

The major exception is the Mojave Plant in Nevada which has its coal delivered from the Black Mesa Mines in Arizona some 275 miles away by a coal slurry pipeline. While the energy requirements for transportation are comparable for trains and barges, the coal slurry pipeline offers opportunities for conservation of energy and oil by two means: (1) it requires less energy input to move the same number of coal BTU's, and (2) the pumping stations along the coal pipeline route can be supplied by electricity generated from indigenous coal and nuclear sources, while locomotives and tow boats use diesel oil. The coal slurry pipeline also has an efficiency advantage over the alternative of a mine-mouth plant and extra high voltage (EHV) transmission.

Since it requires several years to design and build slurry pipelines, this option may have little potential for energy conservation in the near term (before 1978), but the possible savings suggest that the use of this means of transporting coal over long distances should be encouraged.

While there are many alternatives in the long run, oil provides the greatest flexibility in the near future, which explains its role as the "swing" fuel. As such, oil is probably most susceptible to transportation conservation. Presently, oil is transported by pipeline, barge, rail, and truck, with the efficiency of energy transportation ranging from highest to lowest in that order.

In the short term, the following are the main possibilities for conserving energy in the transportation of coal and oil:

- Amendment of pollution standards to permit the use, in existing plants, of fuel from nearby sources for which these plants were originally built rather than by requiring the use of lower-sulfur coals which are only available at great distances.

  Low-sulfur fuel requirements of some industrial and utility plants located in the Northeast have frequently been supplied by natural gas or oil from the South Central areas. The transportation of fuels to the Northeast uses significant amounts of energy, and, by creating a shortage of fuel for power plants near the petroleum and gas fields, necessitates the expenditure of additional transportation energy to provide these South Central plants with supplies from other areas.

  A recent example of this problem concerned the municipal utility of San Antonio, which found that its local gas suppliers could no longer meet commitments and that it could not obtain oil supplies, even though located in the largest petroleum producing state in the Nation. The city was forced, therefore, to redesign a unit under construction to burn coal. The coal is to be supplied from Western coal fields 1,500 miles away.

- In areas where unit trains are used to transport coal to power plants, electrification of the rail lines would aid in the conservation of scarce distillate fuel by permitting its replacement with electrical energy produced from coal and nuclear sources. Although this is not feasible on routes requiring the use of many interchanges and secondary trackage, it may be applicable to certain short-haul unit train circuits and could be implemented within a couple of years.

Voltage Reductions

In the recent past the common problem to which a utility responded by reducing voltage was lack of generating capacity during periods of peak load. Whether or not the energy taken from a load peak was supplied during later off-peak periods was of little consequence. However, today's energy shortage must not be viewed as a capacity shortage. Any plan to conserve energy must take into consideration the possibility that an apparent savings may be accompanied by a loss at another time. Net savings should clearly be the criterion.

Some experts doubt the effectiveness of voltage reductions as energy saving measures. For instance, thermostatically-controlled resistors (e.g., electric space heaters and ovens) would simply operate longer and electric motors would draw more current, with the net result being that both would use the same amount of energy as without voltage reductions. Older electric motors may be damaged by large voltage reductions, but utility contingency plans do not normally call for reduction to levels which would damage such machinery.

Some other effects that could be expected from a prolonged reduction of voltage include incandescent bulbs lasting longer and fluorescent tube lives being shortened. The lives of resistance heating devices and television sets would not normally be affected.

Under operation with reduced voltages, lighting would definitely use less electrical energy, and resistance heating might use slightly less, definitely not more. Motors would use about the same amount of energy as under normal voltage conditions. Lights would not be as bright, and cooking, clothes drying and water heating might take longer. TV picture quality might be reduced.

Since the greatest energy savings occur when the voltage reduction is imposed on the greatest lighting load, the NEPEX conservation program during the winter of 1973-1974 involved a 5-percent voltage reduction from 4 p.m. to 8 p.m. each of the 5 workdays. The most advantageous time of the year for instituting a voltage reduction is clearly the winter when natural lighting is least available.

Net energy savings attributable to a voltage reduction are difficult to determine, even while actually conducting a voltage reduction program. During the first days of the NEPEX voltage reduction, the net estimated savings relative to projected energy demand were achieved. However, the average ambient temperature was higher than expected and a mUltitude of voluntary conservation measures were also in effect. Factors such as these can mean that the contribution from the voltage reduction alone may only be determinable with accuracy after a good deal of operating data has been analyzed.

NEPEX speculated that the reduction in total energy consumption due to a 5-percent voltage reduction between the hours of 4 p.m. and 8 p.m. on each of the 5 workdays was less than 1 percent. Recently, the utility industry was required to report to the Federal Power Commission (FPC) the energy savings expected by a voltage reduction.* The New England region reported a savings in the area of one-fourth of 1 percent. If one assumed that this fraction would be fairly constant across the country and the nearly 2 trillion KWH's would normally have been produced during 1974, the potential savings from voltage reductions would have been about 5 billion KWH's with an associated energy conservation of 20 thousand barrels per day of oil equivalent.

* FPC Order 496, Form 19.

Other Station or System Use

Generating Plants

Lighting within plants could be reduced to the minimum necessary for safely carrying on work. All generating room lights might normally be turned off during daylight hours except when work warrants additional lighting, and only minimum lighting left on at night. Lights in all unattended areas could be turned off when work is completed. Switchyard lights may not be necessary except for certain unattended locations where security is a problem. Building and spillway illumination could be turned off except for that lighting used to illuminate warning or danger signs. Likewise, roadway and parking lighting could be reduced by at least half.

Lighting and temperature levels in occupied areas can be aligned with the standards set for office buildings, while levels in other areas could be reduced to absolutely essential requirements with due regard to need for protection against freezing or unnecessary employee exposure. Energy can also be saved by minimizing, whenever possible, the use of auxiliary equipment such as air compressors, ash sluice pumps, condenser circulating water pumps, boiler circulating water pumps, draft fans, pUlverizers and vibrating equipment.

Central Office Buildings

Lighting in unoccupied office space could be turned off even for short periods of time, and ornamental and exterior building floodlighting reduced or in some cases eliminated.

Heating thermostats could reasonably be set to close when a temperature of 65°F is reached and to open when a temperature of 68°F is reached. Cooling thermostats on the other hand could be set to close when a temperature of 79°F is reached and to open when a temperature of 76°F is reached. The complete shutdown of heating and cooling equipment at night is not considered economical. However, when space is to be unoccupied over a weekend or long holiday, reducing or shutting down the equipment is a possibility.

In many cases, makeup air used in the air conditioning system could be reduced and the supply of conditioned air to unoccupied space turned off except where freezing would be a problem. Central air systems should be properly balanced and filters cleaned regularly to ensure adequate circulation and to minimize required fan horsepower.

Distribution and Transmission System Substation

Lighting could be reduced except in cases where the safety of people or security of property is involved. At unattended stations, building temperature controls could easily be set as low as 40°F in winter and as high as 90°F in summer, except when employees are working in them. At attended stations, temperature adjustments should be made in accordance with regular office building standards.

Burning Refuse

The consumption of fossil fuels can be reduced, in part, through the substitution of man-made fuels. An example of the latter is the combustible component of the waste recovered by municipal trash collection agencies. Historically, this waste has not been utilized in steam boilers because of the availability of other inexpensive fuels and the acceptability of alternate waste disposal methods such as land fills, dumping at sea, open burning, or closed burning in municipal incinerators. With growing scarcities of suitable landfill areas and inexpensive fuels, as well as increasingly strict environmental controls, municipalities and utilities may find it mutually advantageous to recover heat from refuse incineration.

Roughly 70 percent, by weight, of the refuse normally collected may be shredded to proper size for combustion in coal-fired boilers. The combustible component has about two-thirds of the heat value of low-sulfur coal. No adverse boiler effects have been observed to date in units that utilize small amounts of prepared waste to replace some of the usual fuel; in most cases, about 10 percent of the heating energy supplied to the boiler is from this waste. The principal technical problems are in the preparation phase of the refuse, where the material must be shredded and the noncombustibles and metals separated from the usable trash.

The long-term operational and maintenance costs of the refuse preparation equipment are uncertain, but they are expected to be much less than operating cost of incinerators. No significant increase is anticipated in the "real" cost of operating and maintaining the boiler equipment and auxiliaries.

The impact of steam-generating incinerators will remain small in the pre-1978 period, since a typical project is likely to require 3 to 4 years from the initial study phase to operation of the unit. However, the 1970 National Power Survey conducted by the Federal Power Commission estimated that 5 to 10 percent of the Nation's electric power requirements could ultimately be produced from municipal refuse. While the capital costs of a typical fuel preparation plant are not insignificant, they are less than the costs associated with an acceptable new incinerator. In the case of a 1 thousand ton per day refuse preparation facility being built in Chicago, the $14 million plant has permitted the city to defer construction of a $40 million incinerator. The city will amortize the investment through the sale of the prepared trash on the basis of its heating value for use in boilers owned by Commonwealth Edison Company. The city projects an additional $200,000 annual revenue from the sale of recycled metals. An estimated savings of $600,000 annually is expected in operating costs of the new plant compared with the present methods of disposal. In St. Louis, the municipal government and Union Electric recently have announced the expansion of their demonstration operation.

The net environmental impact of steam incinerators is a major advantage of the concept. The refuse is completely reduced to ash in the steam boilers, as opposed to only partial combustion in incinerators. Chemically, the refuse is quite similar in regular composition to low-sulfur coal so no new boiler pollution control devices are needed, assuming the boiler already utilizes precipitators. Only the completely inert and odorless heavy nonmetallic waste remains for disposal by the municipality.

Contractual arrangements for steam incinerator projects must include provisions to permit the utility to meet its responsibility to provide reliable electric service in the event of difficulties in preparing and burning the refuse. One such provision is that fuel must be delivered on a regular basis or storage must be provided for fuel which cannot be used at the time of delivery. The utility must be allowed to refuse garbage which is not combustible. Another example is that the contract must allow the utility to avoid taking more garbage fuel than it can mix with its regular supply and still operate its boilers reliably.

Use of Combustion Turbines for Reduction of Heat Rates of Old Oil-Flred Steam Plants

In some instances where old high heat-rate boilers are being used for peak power generation, it may be desirable to evaluate potential energy conservation benefits from use of combustion gas turbine exhaust for unit repowering. Such combined cycle repowering may be divided into two categories: (1) boiler repowering and (2) steam turbine repowering.

Boiler repowering is accomplished by supplying hot gas turbine exhaust gases to an existing boiler. Performance benefits from this type of change are dependent upon the original boiler design, and each system is generally subject to complete re-engineering to obtain optimum results. It is difficult to estimate ranges of new investment costs for this type of application. Reduction in heat rate experienced in actual plant revisions have been in the order of 4 to 5 thousand BTU's per KWH.

Steam turbine repowering is accomplished by supplying steam to an existing turbine through utilization of added gas turbine combustion equipment and new boilers. The gas turbines exhaust through waste heat boilers and generate steam for the steam turbine. The systems provide added flexibility for both short- and intermediate-range peak-load generation. Investment costs are estimated to be in the range of $65 to $70 per KW of total plant output, based on new gas turbines providing about 65 percent of such capacity. Installation lead times are currently estimated to be from 18 to 36 months. New heat rates would be in the range of 9 to 10 thousand BTU's per KWH.

POSTPONING OR MODIFYING IMPLEMENTATION OF AIR AND WATER POLLUTION CONTROL REGULATIONS

Air and water quality regulations have been adopted in recent years in the United States in an effort to bring about needed improvements in environmental quality.* However, these regulations were designed and implemented to improve the environment at a time when energy seemed plentiful. Given the apparent need to conserve energy and considering the economic impact of environmental changes, it may be necessary to establish a new balance between environmental improvement and fuel conservation, at least in the interim.

In the electric power industry, environmental regulations have already had a significant impact on the use of primary energy, and additional impacts can be foreseen for the 1975-1978 period as more of the regulations become effective. Although environmental standards are clearly needed to protect the health and welfare of the Nation, there is evidence that certain standards are more restrictive than necessary and could be relaxed or modified without causing significant adverse effects on human health.

Postponing or Modifying Implementation of Air Emission Control Regulations

Sulfur Dioxide (S02) Control Regulations

Most state regulations placed restrictions on SO_2 emissions from all sources, including electric power plants. Regulatory agencies are pressing for the use of stack gas desulfurization equipment (scrubbers) to minimize S02 emissions at coal-fired electric power plants. There continues to be some disagreement between the Environmental Protection Agency (EPA) and certain utilities about feasibility and costs. S02 scrubbers have frequently proven unreliable and they are expensive. The cost of backfitting scrubbers can range from $60 to $100 per KW of capacity. Furthermore, SO_2 scrubbers have some effect on energy supply because of the energy requirements to operate various fans, motors, pumps and other components of the scrubber system. It is estimated that between 6 to 8 percent of plant capacity may be required to operate scrubber systems. For each 1,000 MW of capacity equipped with S02 scrubbers, an equivalent of 96 barrels of oil would be consumed for each hour of scrubber operation.

The EPA recently estimated that flue-gas desulfurization will be needed on some 90,100 MW of coal-fired generating capacity by 1980. The energy equivalent of about 45 million barrels of oil per year (123 thousand barrels per day) would be required to operate this equipment. It is estimated that by 1978 about two-thirds (80 thousand barrels per day) of the total would be used for this purpose, which represents the energy savings potential associated with <u>deferring</u> these measures beyond 1978.

* This report merely states the facts regarding the interrelationship between environmental control and energy conservation' it does not take positions on ecological goals.

This estimate does not include requirements for additional scrubbers on oil-fired plants being converted to coal.* Furthermore, the mining and transportation of large quantities of limestone would consume additional energy, as would the disposal of scrubber waste material.t Thus, if stack gas scrubbers are used for attaining and maintaining ambient SO_2 standards, a significant amount of energy (and capacity) would be required to operate the equipment.

For properly sited large plants, use of intermittent controls could reduce energy requirements for meeting primary or secondary ambient air standards because the meteorological conditions which cause high ground-level concentrations occur only infrequently, i.e., less than 5 percent of the time. Such conditions can usually be forecast in advance, allowing the power plants to intermittently switch fuels or alter operations (environmental dispatching) to reduce emissions during these periods and thus avoid exceeding standards.

Ground-level SO_2 concentrations around large power plants can often be substantially reduced by increasing stack height at the source. If state implementation plans were to permit increased stack height as an acceptable control strategy for SO_2, where appropriate, additional shifts back to more available fuel would be possible.

Present SO_2 emission standards can also be met by burning low-sulfur coal in power generating plants. Such coal is not readily available in the eastern United States, but there are large reserves of low-sulfur subbituminous coal in the western United States. The feasibility of burning low-sulfur western coal has been tested in plants designed for bituminous eastern coals. The high moisture and low BTU content of this coal have resulted in reported reductions in generating capability of as much as 15 to 30 percent. Furthermore, transportation costs to most eastern plants are significant, particularly in light of the current shortage of coal hauling equipment. Also, the use of low-sulfur coal can adversely affect electrostatic precipitator performance and thus increase fly ash emissions. The most judicious use of the limited quantities of eastern low-sulfur coal and western coal in existing boilers would be in conjunction with intermittent control methods, if such methods were permissible.

---

* If scrubbers had to be used on convertible oil/coal plants in conjunction with their conversion to coal, an additional 35 thousand barrels per day of oil equivalent would be required in 1978, assuming complete oil to coal conversion of all such plants currently burning oil.

t Other systems of SO_2 removal not using lime or limestone would avoid these energy costs; however, such systems normally require even more auxiliary power for the sulfur removal process and are generally no further along the development path.

Barring R&D breakthroughs for desulfurizing fuels or scrubbing stack gases, fairly long-term variances to current sulfur standards will have to be assured before necessary increases in coal supply can be attained. The coal industry is hesitant to open new mines or expand production because of uncertainties in the marketability of higher-sulfur coal and pending strip mine legislation. The two principal requirements for overcoming this hesitancy are: (1) long-term contracts between the utilities and suppliers (this will require assurance to the utility that solutions to the air standards problem will be long term); and (2) resolution of the environmental issues surrounding mining operations.

Temporary relaxation of emission control requirements for new coal-fired power plants might be expedient for encouraging immediate increases in generating capacity. Lead times for adding new coal-fired plants are normally much shorter than for nuclear plants, yet many power systems are unable to add new coal-fired capacity because proven methods for controlling SOZ emissions are not commercially available. Immediate and temporary suspension of SOZ emission requirements for new plants until satisfactory SOZ emissions systems become available may result in additional generating capacity being brought into service during the late 1970's, thus reducing reliance on oil-fired generation at an earlier date than might otherwise be possible. In the interim, the possibility of using higher-sulfur fuel oil or crude oil would permit an easing of the present strains on utility fuel supplies.

Particulate Regulations

Energy consumption of high-efficiency electrostatic precipitators is on the order of 0.1 to 1.5 percent of station output. It is unlikely that it would be acceptable to operate plants with no control on particulate emissions even if standards were to permit it. Therefore, relaxation of present standards would result in only a small energy savings.

Postponing or Modifying Water Pollution Control Regulations

The Federal Water Pollution Control Act Amendments of 1972 became law on October 18, 1972. One of the major provisions of this law is the requirement for controlling heated condenser water discharges from steam-electric power plants. All steam-electric power plants (both fossil-fired and nuclear) must release heat to the environment because only a portion of the thermal energy of the fuel is converted to electrical energy. Most of the remaining heat is absorbed by the cooling water passed through the condenser. The guidelines for thermal discharges have been developed by EPA and were published for comment in March 1974. The preliminary version of these guidelines indicates that, if finally adopted, about 95 percent of all existing steam-electric power plants will require the installation of the Best Practicable Technology (BPT) as represented by closed-cycle cooling facilities by July 1, 1977, and all but peaking plants will require the Best Available Technology (BAT) as represented by closed-cycle cooling facilities by July 1, 1983. Closed-cycle cooling facilities will also be required on any new steam plant constructed, whether coal-fired or nuclear.

The installation of closed-cycle condenser cooling systems to meet the EPA proposed thermal effluent guidelines may cause capacity losses due to increased turbine back-pressure and the power requirements for the fans and pumps for the cooling towers. The capacity losses by 1978 may range from 2 to 6 percent of the total generating plant capacity (equal to 68 to 208 million barrels annually of oil equivalent or 186 to 570 thousand barrels per day).

In the short term, conservation of energy by relaxation of present regulations relative to water quality standards may not be large. This is because only about 20 percent of the steam-electric generating plants now in operation use auxiliary cooling. Those plants in water-short areas will require continued use of auxiliary cooling. This leaves a smaller percentage that could return to once-through cooling.

The thermal effluent limitation guidelines now under consideration by EPA will create a large longer-term energy requirement. A substantial portion of this energy could be conserved, perhaps permanently but at least temporarily, without major damage to the environment.

OIL SAVINGS

Although the potential for total energy conservation in the production and distribution of electricity is not proportionately large in the 1974-1978 time frame, a considerable potential exists for conserving scarce petroleum fuels. More intensive use of nuclear plants, as described in the following three sections, would ease the overall energy shortage and save oil as well.

MODIFICATION OF NUCLEAR PLANT LICENSING SCHEDULES AND REVIEW OF PLANT DERATINGS

Increased utilization of nuclear power plants by the modification of any unnecessarily restrictive regulations would conserve those fossil fuels which are currently in short supply. Because of the rapid introduction of very large nuclear power plants, the licensing standards governing the design and operation of these plants have presented utilities with an evolving and sometimes ambiguous body of technical criteria on which to base plant construction. The regulatory bodies involved, most notably the United States Atomic Energy Commission (AEC), are perfectly aware of this dilemma and seem to be making a substantial effort to alleviate it; however, it now appears likely that a great deal of nuclear capacity and energy output which could be made available will go unused. On the other hand, neither electrical producer nor consumer could reasonably expect the energy crisis to pressure the AEC into relaxation of nuclear guidelines which are needed to protect the safety of the public.

For purposes of this study, nuclear generating facilities can be classified according to those that are operating and those that will come on-line within the next few years.

Currently Operating Plants

Because of extensive news coverage on the derating of nuclear plants, there is an incorrect impression that a substantial number of nuclear plants are presently derated and will continue to be derated throughout 1974. A number of nuclear plants are now slightly derated. However, the reactor manufacturers and the AEC are examining more detailed models analyzing the hypothesized "loss of coolant accident" (LOCA) and the effects of fuel densification (the major cause of derating) to determine whether derated plants may operate safely at full power.

There are two other classes of problems which are separate and distinct but which are sometimes incorrectly included in nuclear safety and licensing issues. These are mechanical malfunctions of conventional steam equipment and fuel failures by hydriding. Any large generating plant, either fossil-fueled or nuclear, has many components which require periodic maintenance and repair. The mechanical reliability of nuclear units has been demonstrated to be comparable to that of fossil-fueled units of the same size. There are no pertinent generic regulatory standards which may be reasonably analyzed for possible modification in order to improve plant mechanical reliability.

Several boiling water reactors (BWR) have been derated temporarily because of "hydriding" of the fuel cladding; a weakening of the characteristics of the metal due to exposure to the hydrogen in water, believed to be aggravated by high temperature and intense radiation. Resulting breaches in the cladding release gaseous fission products which, after considerable radioactive decay, are released to the atmosphere. These radioactive gases may not be released in excess of well-defined limits established by the AEC.

Reducing power is one method of reducing release rate of these gases. Since not all fuel has suffered the hydriding problem, this type of fuel failure can be eliminated by fuel design modifications. Nuclear fuel manufacturers have been working on the problem for almost two years, and it can be expected that hydriding will be eliminated as a cause for derating within the next few years. The problem has already been substantially reduced, and it would be difficult to justify higher release limits in light of the existing AEC rationale for the current limits. Moreover, there is frequent criticism from state agencies and others to the effect that current limits are already too high. In any event, the majority of operating pressurized water reactors (PWR's) are not encountering hydride problems.

The inability of some plants to meet specified safety criteria, during the hypothetical loss of coolant accident, has resulted in deratings after an additional set of guidelines was imposed which included effects of the recently observed phenomenon of fuel densification. The analysis which correlates the occurrence of a loss of coolant accident to its consequences is highly sophisticated and requires numerous conservative technical assumptions. When combined, these assumptions produce an overall result which is extremely conservative. Since the fuel densification phenomenon has actually been experienced, the additional guidelines associated with densification alone are difficult to criticize. During the next few years, fuel experience plus redesign should eliminate densification as a source of significant concern.

Even under the assumption of a continued densification problem, more detailed (and therefore more accurate) analytical models now under consideration by the AEC, may eliminate deratings resulting from the recently published Emergency Core Cooling System Criteria.

Possible Energy Effects of Deratings

Over the next 3-½ years some 35,000 MW of nuclear capacity will probably be added, bringing total nuclear capacity in service to about 55,000 MW. Under the following assumptions, deratings could cause a total generation loss of about 24 billion KWH. Assume that:

(1) deratings affect two-thirds of the current capacity and one-fourth of the capacity to be added during the next 3 years (some redesign is possible for plants added during the latter part of the 3-year period); (2) the full 3 years of derating would be experienced for the operating plants; (3) derating of a year and a half would apply to the plants to be added; (4) all plants have a 70-percent capacity factor; and (5) an average derating of 7-½ percent would be in effect. This overall derating would be equivalent to a loss of 38.2 million barrels of oil over the next 3 years or 35 thousand barrels daily.

Nuclear Plants to be Brought On-Line in the Next Five Years

The current energy shortage has highlighted the detrimental effects on the economy and national security that delays in bringing new units on-line might have. A firmer stand by the government against further plant delays caused by issues and procedures *not related to public safety or interest* is now becoming evident. Unfortunately, quantitative estimates as to the increased nuclear generation resulting from efforts to bring nuclear units on-line as scheduled, or earlier than scheduled, are simply impossible to make. The July/August 1973 edition of *Nuclear Safety* (an AEC publication) gives data on capacity and scheduled startup dates for nuclear plants now docketed with the AEC. The data in Table 2 are based on this publication, assuming that the startup schedules can be maintained during the period 1974 to 1978. It is apparent that a "slippage" of one year in the schedule would increase the demand for fossil fuels by the equivalent of approximately 300 million barrels of oil over the 4-year period.

TABLE 2

SCHEDULED NUCLEAR PLANT CAPACITY

Year	Number of Plants	Capacity (MW)	Cumulative Daily Consumption of Oil Equivalent* (Thousand Barrels)
1974	13	12,103	1,034
1975	16	15,206	1,442
1976	8	7,656	1,648
1977	9	9,197	1,895
1978	3	3,328	1,985

*Assumes a 70-percent capacity factor.
SOURCE: *Nuclear Safety*, July/August 1973.

Nuclear plant construction is hampered in three ways: (1) revisions of AEC criteria during construction, (2) material shortages and (3) labor shortages. Given the constraints in these areas, it is unlikely that the utility industry can bring plants on-line faster than present schedules. On the other hand, these constraints could well cause further delays in bringing nuclear plants on-line.

The AEC is considering and, where possible, implementing many constructive measures to avoid delaying effects of changing criteria. Critical material shortages have developed in such areas as valves, pumps, reinforcing bar and copper components. The effects of Phase IV price controls and environmental restrictions on domestic foundries have been partly responsible for these shortages. Labor shortages are equally detrimental. Nuclear plant construction has the inherent problem of being remote from the bulk of the skilled labor market and requiring a large, but temporary labor force.

OIL TO COAL CONVERSIONS

The recent embargo on Arab oil exports to the United States has focused attention on the potential for substituting coal for oil in those power plants capable of switching from oil to coal. Some conversions have been accomplished in response to the 1973-1974 winter's supply crisis. However, changeovers have been limited because of numerous problems, chief among which have been shortages of coal that would be compatible with the boilers and environmental constraints imposed by state and local air pollution control authorities.

Existing Conversion Potential

In early 1973 the Federal Power Commission surveyed the electric utility industry to determine the real extent of oil-to-coal and gas-to-coal reconvertibility (i.e., the amount of capacity which, at the time of the inquiry, was burning primarily oil or gas but had been originally equipped to burn coal and which utilities thought could be technically and economically reconverted to the use of coal).* The results of this survey were issued in the autumn of 1973.t Based on 1972 installed capacity, the survey showed that there was a potential for conversion of oil-fired capacity to coal which could result in a savings of nearly 500 thousand barrels of oil per day, i.e., approximately one-third the utilities' oil burn rate in 1973.

---

* Theoretically, if sufficient space were available at the power plant site for installing coal handling and coal storage facilities, and if sufficient time and money were expended, plants which had been designed to burn only oil could also be converted to coal. However, few if any such conversions are likely to be made by 1978.

t Federal Power Commission, "The Potential for Conversion of Oil-fired and Gas-fired Electric Generating Units to Use of Coal," a Bureau of Power Staff Report, September 1973. Revised November 6, 1973.

Factors Affecting Convertibility

Aside from problems of restoring to operating service the physical facilities for handling and burning coal, the main factors which could retard or prevent complete reconversion are: availability of coal for the boiler, availability of transportation, adequate variances of environmental regulations to permit its burning and the ability of electric utilities to obtain suitable contractual relationships with suppliers of fuel. While each of these factors could be discussed at length, it is sufficient for the purposes of this discussion to note that the necessary additional fuel and transport facilities will be made available, only if the utilities are granted authorization to use coal for extended periods of time. Neither mine operators nor railroads can reasonably be expected to make large additional investments in plants, unless they are assured of a need for their products and services of sufficient duration to recover their investments. Conversions without these assurances would have to rely on spot markets for both fuel and transport capacity--with all their associated uncertainties as to price and continuity of supply.

USE OF ALTERNATE LIQUID PETROLEUM FUELS FOR BASE-LOAD AND PEAK-LOAD ELECTRIC POWER GENERATION

Base-Load Generation

The use of crude petroleum as boiler fuel instead of conventional residual-type fuels, has been practiced in Japan for about 12 years. Prior to the recent Middle East oil embargo, the rate of use in that area was in excess of 70 million barrels per year. Japan's long-term experience has clearly established that crude oil can be used safely in a properly designed and operated fuel storage, handling and combustion system.

Limited use of crude oil as boiler fuel was initiated in the United States in 1971. A number of U. S. plants have since been retrofitted, or originally designed, to burn crude oil to achieve maximum fuel choice flexibility. Recently the California Public Utility Commission (PUC) requested that some oil-fired plants be modified for potential use of crude oil as boiler fuel.

Recent studies of governmental air pollution control groups have indicated that a significant number of East Coast utility power plants could burn petroleum fuels with sulfur contents as high as 3 percent without preventing achievement of primary national sulfur dioxide standards. This suggests that, in the event of temporary refining capacity shortages when crude oil is available, consideration could be given to the alternative of burning crude oil. In such cases, the energy savings would be equal to the losses in normal refining processing, i.e. 5 to 10 percent, plus some additional energy that may be required for the production and transportation of conventional fuel.

Approximate additional investment costs for retrofitting existing power plants for crude burning would vary depending on a number of factors, including local regulations and design of existing fuel handling and boiler systems. Generally they would be expected to fall in the range of $3 to $6 per KW of generation capacity. Construction lead times for modification of existing plants might fall in the range of 10 to 20 months.

Peak-Load Generation

Programs for optimization of liquid petroleum energy resources should consider the possibility of using alternate types of fuels (other than No. 2 distillate grade) in some combustion turbine facilities. Sufficient experience on the part of utilities and other industrial plants has demonstrated that gas turbines can be operated on a wide range of other liquid petroleum fuels such as crude oil, naphtha, heavy distillates and heavy residual fuel oils. Use of alternate fuels in combustion turbines would tend to reduce utility consumption of No.2 fuel supplies, thereby easing strains on supplies for other equipment such as home heating oil burners and automotive and railroad diesels.

If utility gas turbines were to be provided with greater fuel-source flexibility, additional capital investment would be required for turbine modifications and greater complexity of fuel storage and handling systems. Maintenance costs, maximum generation capacity and generation availability could be adversely affected, and total energy required per unit of generation might increase somewhat, depending on combustion quality and other characteristics of the alternate fuel being used.

Information has been obtained from a number of utilities and equipment manufacturers concerning the range of effects of using alternate fuels on utility gas turbine peak power generation operations. The following general observations were based on this survey:

- Alternate fuels might be used in utility peaking gas turbine systems to optimize utilization of liquid petroleum fuels. They include naphthas, heavy distillates, crude oils and selected residual fuels.

- Modification of existing systems to accommodate alternate fuels would require additional investments and changes in modes of operation. The amounts of additional investment and changes in operational procedures required are generally related to boiling range and volatility characteristics of the alternate fuels being considered. Use of heavy residual fuels requires the largest investments and operating changes. Their use also generally imposes some reduction in the maximum power generation capacity of gas turbine peaking systems.

- Total equipment investments after retrofitting of existing simple-cycle gas turbine peaking systems for use of alternate fuels are approximately 10 to 15 percent more than would have been expected if the system had been originally designed for use of the alternate fuel.

EXTENDED USE OF SYSTEM INTERTIES

A possibility exists for increased transfer of electricity among some regions of the United States. This effort would not necessarily conserve energy; in fact, there would be a small energy penalty because of transmission losses; however, the shifting of some of the burden of energy production to regions with more plentiful supplies of coal-based, hydro, or nuclear generated energy could help to alleviate fuel scarcity in regions relying principally on oil-and gas-fueled stations.

The ability to transfer energy among regions is influenced by both technical and nontechnical constraints. Within the boundaries of these constraints, the regional reliability councils, through the National Electric Reliability Council, have participated in studies of power system configurations and inter- and intraregional power transfer capabilities in order to guarantee the adequacy and reliability of the Nation's bulk power supply. As a result of these and other studies, utilities have developed long-range plans for the construction of. additional interties with their neighbors. Although these interties have been and are being developed to ensure a reliable and guaranteed bulk power supply, they might also be used for the purpose of relieving fuel shortages in selected areas on a periodic basis.

New interties that could be constructed within the time frame of the next 5 years have already been planned or already are under construction. The existing transmission system may provide some capability for power transfer beyond what would be used in the course of normal operations; however, not all parts of the system have been designed to permit extended periods of power transfer, rather they were designed for short-term capacity deficiencies.

Most of the power transferred would have to occur during off-peak hours. Operating contingencies would periodically reduce the transfer capabilities and the actual daily schedules would have to be determined by the operations personnel at the dispatch control centers in the areas. Nonetheless, interregional power transfers should be encouraged when possible.

As one measure of the potential savings that can result, a study undertaken by power industry representatives under the auspices of the Interregional Review Subcommittee of the National Electric Reliability Council's Technical Advisory Committee reviewed the possibility of saving residual oil in the Northeast Power Coordinating Council (NPCC) and Mid-Atlantic Area Council (MAAC) regions. The replacement energy could come from coal and nuclear stations in the East Central Area Reliability Coordination Agreement (ECAR) and Mid-America

Interpool Network (MAIN) regions.* The report estimated that during the first quarter of 1974, 30 thousand barrels of residual oil per day could be displaced by the transfer of such energy in the general area stretching from New England to Washington, D.C. This represents a rate of power transfer of from 1,000 to 3,000 MW and an average daily delivery of 20 million KWH. The coal required would be about 10 thousand tons per day. The technical aspects of the transmission of electrical energy and the matter of compensation were not addressed by the report.

Transmission interties may also permit the transfer of power into the California area and South Central regions of the United States, where imported oil and/or natural gas are extensively used. The Tennessee Valley Authority (TVA) coal-and nuclear-based area might be able to supply intermittently 2,100 MW to the Gulf Coast based on the projected 1976 transmission system. This nonsimultaneous peak supply would represent 60 thousand barrels per day of oil equivalent energy. The Northwest area, if sufficient water levels permitted, might be able to export 3,550 MW of power to the California/Nevada area by 1976. This could displace about 100 thousand barrels per day of oil equivalent energy, again however, on a less than regular basis.

---

* National Electric Reliability Council, *Potential Savings of Residual Oil in PAD I by Transmission of Energy from Remote Coal-Fired Generation.* Supplemental report by the Ad Hoc Transmission Task Force of the Technical Advisory Committee, Princeton, N.J.: January 23, 1974.

Appendices

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In Reply Refer To:
AS-EM

July 23, 1973

Dear Mr. True:

In his energy statement of June 29, the President announced additional steps being taken to conserve America's fuel supplies and their use, and called upon private industry to respond to the energy conservation directives with all the imagination and resourcefulness that has made this Nation the richest on earth.

In December 1972, the National Petroleum Council submitted to me a comprehensive summary report on "U.S. Energy Outlook," the supporting detailed task force reports being now received for each fuel as completed. The results of this exhaustive work done by the energy industries has been of major value to the Department and other agencies of Government, shedding considerable light on the U.S. fuel supply situation in particular.

In order to further assist us in assessing the patterns of future U.S. energy use, the National Petroleum Council is requested to conduct a study which would analyze and report on the possibilities for energy conservation in the United States and the impact of such measures on the future energy posture of the Nation.

You are requested to submit a progress report by January 1, 1974.

Sincerely yours,

Rogers C B Morton

Secretary of the Interior

Mr. H. A. True, Jr.
Chairman
National Petroleum Council
1625 K Street, N. W.
Washington, D. C. 20006

The following industry representatives have participated in this Energy Conservation Study.

ELECTRIC UTILITY TASK GROUP
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON ENERGY CONSERVATION

CHAIRMAN

Thomas H. Burbank
Vice President
Edison Electric Institute

COCHAIRMAN

Dr. Charles A. Berg
Chief Engineer
Federal Power Commission

ASSISTANT TO THE CHAIRMAN

J.L. Schenck
Assistant Director
Economics and Statistics
Edison Electric Institute

SECRETARY

Peter J. Cover
Committee Coordinator
National Petroleum Council

* * * * * *

S. P. Cauley
Product Line Manager
Distillate and Residual Fuel
Corporate Products Department
Mobil Oil Corporation

H. L. Deloney
President
System Fuels Inc.

Joseph S. Ives
Environmental Counsel
National Rural Electric
Cooperative Association

V. M. Johnston
Manager, Economic Services
Island Creek Coal Company

Rene Males
Manager, General Services
Commonwealth Edison Company

W. H. Seaman
Vice President
Southern California Edison Co.

H. W. Sears
Vice President
Northeast Utilities Service Co.

T. Graham Wells, Jr.
Assistant Manager for Power
Tennessee Valley Authority

W. L. Wright
Consultant
Power Generation Systems
Westinghouse Electric Corporation

SPECIAL ASSISTANTS

James R. Burdeshaw
Director, Power Marketing
Tennessee Valley Authority

L. C. Grundmann, Jr.
Engineering Manager
System Fuels Inc.

John Ladesich
Manager, Nuclear Fuel Supply
Southern California Edison Co.

Dallas Marckx
Fuel Assistant, Nuclear
Northeast Utilities Service Co.

NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON ENERGY CONSERVATION

CHAIRMAN

Maurice F. Granville
Chairman of the Board
Texaco Inc.

COCHAIRMAN

C. King Mallory
Deputy Assistant Secretary
for Energy and Minerals
U.S. Department of Interior

VICE CHAIRMAN

C. H. Murphy, Jr.
Chairman of the Board
Murphy Oil Corporation

SECRETARY

Vincent M. Brown
Executive Director
National Petroleum Council

EX OFFICIO

H. A. True, Jr.
Chairman
National Petroleum Council
c/o True Oil Company

* * * * * *

Jack H. Abernathy
President
Big Chief Drilling Company

Howard W. Blauvelt
Chairman of the Board
Continental Oil Company

H. Bridges
President
Shell Oil Company

Collis P. Chandler, Jr.
President
Chandler & Associates, Inc.

O. C. Davis
President
Peoples Gas Company

Robert H. Gerdes
Chairman of the Executive
Committee
Pacific Gas and Electric Company

John W. Hanley
President
Monsanto Company

F. Donald Hart
President
American Gas Association

Fred L. Hartley
Chairman of the Board
and President
Union Oil Company of California

H. J. Haynes
Chairman of the Board
Standard Oil Company of California

P. N. Howell
Chairman
Howell Corporation

Frank N. Ikard
President
American Petroleum Institute

Robert D. Lynch
Vice President
National Oil Fuel Institute, Inc.

W. F. Martin
Chairman
Phillips Petroleum Company

Tommy Munro
President
National Oil Jobbers Council, Inc.

R. E. Seymour
Chairman of the Board
Consolidated Natural Gas Company

Chas. E. Spahr
Chairman of the Board
The Standard Oil Company (Ohio)

Thomas F. Strook
Strook, Rogers & Dymond

Rawleigh Warner, Jr.
Chairman of the Board
Mobil Oil Corporation

M. A. Wright
Chairman and Chief
Executive Officer
Exxon Company, U.S.A.

POLICY COMMITTEE OF THE NATIONAL PETROLEUM COUNCIL'S COMMITTEE ON ENERGY CONSERVATION

CHAIRMAN

Maurice F. Granville
Chairman of the Board
Texaco Inc.

COCHAIRMAN

C. King Mallory
Deputy Assistant Secretary
for Energy and Minerals
U.S. Department of Interior

VICE CHAIRMAN

C. H. Murphy, Jr.
Chairman of the Board
Murphy Oil Corporation

SECRETARY

Vincent M. Brown
Executive Director
National Petroleum Council

* * * * * *

Collis P. Chandler, Jr.
President
Chandler & Associates, Inc.

Robert H. Gerdes
Chairman of the Executive
Committee
Pacific Gas and Electric Company

Frank N. Ikard
President
American Petroleum Institute

Robert D. Lynch
Vice President
National Oil Fuel
Institute, Inc.

G. J. Tankersley
President
Consolidated Natural
Gas Company

COORDINATING SUBCOMMITTEE
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON ENERGY CONSERVATION

CHAIRMAN

R. C. McCay
Vice President
Public Relations & Personnel
Texaco Inc.

COCHAIRMAN

C. King Mallory
Deputy Assistant Secretary
for Energy and Minerals
U.S. Department of Interior

SECRETARY

Vincent M. Brown
Executive Director
National Petroleum Council

* * * * * *

Dr. Edgar N. Brightbill
Director, Planning
Energy & Materials Department
E.I. duPont de Nemours & Co., Inc.

Thomas H. Burbank
Vice President
Edison Electric Institute

Charles H. Burge
Analyst
Special Studies Office
Murphy Oil Corporation

W. R. Finger
Senior Planning Supervisor
Corporate Planning Department
Exxon Company, U.S.A.

Harvey L. Franzel
Manager Energy and
Utilities Planning
Manufacturing
Shell Oil Company

E. R. Heydinger
Manager, Economics Division
Marathon Oil Company

John H. Lichtblau
Executive Director
Petroleum Industry Research
Foundation, Inc.

Robert D. Lynch
Vice President
National Oil Fuel Institute, Inc.

Howard A. McKinley
Vice President
New Business Development
Western Hemisphere Petroleum Div.
Continental Oil Company

Richard J. Murdy
Vice President & General
Manager
CNG Producing Company

Paul F. Petrus
Manager, Environmental Affairs
Mobil Oil Corporation

Dudley J. Taw
Vice President, Marketing
The East Ohio Gas Company

SPECIAL ASSISTANT

H. W. Wright
Manager, International Market Analysis
Economics Division
Texaco, Inc.

CONSUMER TASK GROUP
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON ENERGY CONSERVATION

CHAIRMAN

Howard A. McKinley
Vice President, New Business Dev.
Western Hemisphere Petroleum Div.
Continental Oil Company

COCHAIRMAN

Einar Windingland
Director Policies and Procedures
Office of Procurement
Federal Supply and Procedures
General Services Administration

ASSISTANT TO THE CHAIRMAN

R. Gerald Bennett
Coordinator, Planning Dept.
Continental Oil Company

SECRETARY

Vincent M. Brown
Executive Director
National Petroleum Council

* * * * * *

David A. Crane
President
Rice Center for Community
Design & Research

Patrick Greathouse
Vice President
United Auto Workers

Dr. Charles M. Huggins
Manager of Liaison
Corporate Research & Development
General Electric Company

Dr. Henry D. Jacoby
Professor of Management
Massachusetts Institute of Tech.

Alvin Kaufman
Director
Office of Economic Research
New York State Public
Service Commission

Paul Swatek
National Treasurer
Sierra Club

Mrs. Elizabeth Wallace
Consumer Affairs Specialist
Washington, D. C.

SPECIAL ASSISTANTS

K. R. Gerhart
Director of Internal
Energy Conservation
Continental Oil Company

J. E. Landers
Director, Fuel Technology
Development
Continental Oil Company

Donald L. Williams
Executive Director
Rice Center for Community
Design & Research

INDUSTRIAL TASK GROUP
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON ENERGY CONSERVATION

CHAIRMAN

Harvey L. Franzel
Manager Energy and
Utilities Planning
Manufacturing
Shell Oil Company

COCHAIRMAN

Dr. Quentin Looney
Chief, Program Development
and Evaluation Branch
Energy Conservation Division
U.S. Department of Commerce

VICE CHAIRMAN

Dr. Edgar N. Brightbill
Director, Planning
Energy and Materials Department
E.I. duPont de Nemours & Co., Inc.

SECRETARY

Peter J. Cover
Committee Coordinator
National Petroleum Council

* * * * * *

Stanley M. Berman
Committee Executive
National Resources Management
and Conservation Committee
National Association of Mfrs.

Gerald L. Decker
Utilities Manager
Petroleum Products & Services
Dow Chemical USA

Roger S. Holcomb
Manager of Engineering
Amoco Oil Company

William Marx
Manager
American Boiler Manufacturers Assn.

Dwight L. Miller
Assistant Area Director
Northern Regional Research Lab.
Agriculture Research Service
U.S. Department of Agriculture

Henry E. Miller
Assistant Vice President
Engineering and Construction
Armco Steel Corporation

Gus G. Pappas
Senior Staff Engineer
Environmental Activities Staff
General Motors Corporation

Dr. C. J. Potter
Chairman
Rochester & Pittsburgh Coal Co.

William H. Sherwood
Senior Staff Buyer
Aluminum Company of America

Dr. Ronald J. Slinn
Vice President
Pulp and Raw Materials
American Paper Institute

PATTERNS OF CONSUMPTION/ENERGY DEMAND TASK GROUP
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON ENERGY CONSERVATION

CHAIRMAN

W. R. Finger
Senior Planning Supervisor
Corporate Planning Department
Exxon Company, U.S.A.

COCHAIRMAN

Dr. Marquis R. Seidel
Senior Economist
Office of the Chief Engineer
Federal Power Commission

SECRETARY

J.A. Coble
Consultant to the
National Petroleum Council

* * * * * *

John M. Abel
Manager
Economic & Corporate Planning
Union Oil Company of California

J. E. Black
Director of Economics
Planning & Economics Department
Gulf Oil Company--U.S.

R. L. Howard
Director, Corporate Economics
and Planning Information
Phillips Petroleum Company

Lee Leibacher
Economics Department
Standard Oil Company (Indiana)

Thomas L. Cranmer
Planning Associate
Planning & Economics Department
Mobil Oil Corporation

Lawrence J. Goldstein
Economist
Petroleum Industry Research
Foundation, Inc.

Edward Symonds
Vice President
Petroleum Department
First National City Bank of
New York

RESIDENTIAL/COMMERCIAL TASK GROUP
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON ENERGY CONSERVATION

CHAIRMAN

Dudley J. Taw
Vice President, Marketing
The East Ohio Gas Company

COCHAIRMAN

Heinz R. Trechsel
Manager Building Program
Office of Energy Conservation
National Bureau of Standards

VICE CHAIRMAN

Richard J. Murdy
Vice President & General Manager
CNG Producing Company

SECRETARY

Marshall W. Nichols
Director Committee Operations
National Petroleum Council

* * * * *

R. A. Beals
Equipment Development Director
National Oil Fuel Institute, Inc.

Franklin P. Blair
Director of Planning
Bryant Air Conditioning Company

Theodore C. Gilles
Corporate Manager
Environmental Systems
Lennox Industries Inc.

Paul C. Greiner
Vice President
Market Development
Edison Electric Institute

James Judge
Executive Vice President
National Association of
Building Manufacturers

John F. Mason
General Manager
Fuel Oil Sales Division
Texaco Inc.

Charles E. Peck
Group Vice President
Owens-Corning Fiberglas Corp.

Kenneth W. Person
Vice President
Business Development
Minneapolis Gas Company

Paul C. K. Smith
Residential Marketing Manager
American Gas Association

Fred L. Tyler
Director
Residential Marketing
Northern Natural Gas Company

SPECIAL ASSISTANTS

John C. Arnold
Research Market Analyst
The East Ohio Gas Company

Jerald W. Foster
Manager
Insulation Market Development
Owens-Corning Fiberglas Corp.

Wallace H. Frick
Technical Marketing Manager
The East Ohio Gas Company

Charles Gallagher
Group Vice President
Owens-Corning Fiberglas Corp.

Glenn Lovin
Washington Representative
Electric Energy Association

Daniel E. Morgenroth
Manager, Market Development,
Construction Group
Owens-Corning Fiberglas Corp.

Warren Waleen
Manager, Central Plant
Development
Minneapolis Gas Company

TRANSPORTATION TASK GROUP
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON ENERGY CONSERVATION

CHAIRMAN

E. R. Heydinger
Manager
Economics Division
Marathon Oil Company

COCHAIRMAN

Myron Miller
Director Office of Transportation
Energy Policy
U.S. Department of Transportation

ASSISTANT TO THE CHAIRMAN

Robert L. Berger
Economics Division
Marathon Oil Company

SECRETARY

Marshall W. Nichols
Director, Committee Operations
National Petroleum Council

* * * * * *

R. G. Ayres
Planning and Economics Specialist
Phillips Petroleum Company

William C. Barnich, III
Director of Government Affairs
National Association of Motor
Bus Owners

Dr. Fred W. Bowditch
Executive Assistant to the
Vice President
Vehicle Emission Matters
Environmental Activities Staff
General Motors Corporation

R. R. Manion
Vice President
Operations and Maintenance
Association of American Railroads

Grant E. Medin
Manager, Energy Analysis Group
Atlantic Richfield Company

John F. Brennan
Assistant to the Vice President
Research & Technical Services Div.
American Trucking Associations, Inc.

Timothy N. Gallagher
Special Assistant for Energy
to the Senior Vice President
Operations and Airports
Air Transport Association of America

Robert A. Brown
Manager, Price Forecasting
and Competitive Studies
Mobil Oil Corporation

Mark W. Owings
Manager, Marketing Economics
Corporate Planning & Economics
Department
Gulf Oil Corporation

John H. Rabbitt
Manager, Industry Affairs
Sun Oil Company

SPECIAL ASSISTANTS

John H. Guy, IV
Associate Committee Coordinator
National Petroleum Council

Rudi Winzinger
Petroleum Economics Analyst
Gulf Oil Corporation

CONSUMER PRACTICES AND CONSUMER ACTIONS

The most significant advances in the efficiency of energy use are probably to be gained through modifications of the practices and equipment used at the point of consumption.* Thus, the response of the consumer to energy conservation programs is of vital importance to their success.

The utilities have a direct and well-recognized influence on consumer decisions regarding utilization of energy--price. If one assumes that normal elasticities will be exhibited in the consumption of electrical power, then increasing prices of electricity should motivate the consumer to use electricity more efficiently. Unfortunately, the experimental evidence required to substantiate the assumed elasticity of electrical energy consumption is incomplete, and that which exists is inconclusive. Nevertheless, the influence of price in conservation efforts might prove to be quite important.

In addition to price, the utilities exert other, sometimes less well-recognized, influences on the energy consumption habits of the consumer. The existing utility operations in marketing. customer service and advertising derive from sales programs which originally had the objective of expanding the use of energy. These operations could be redirected toward conservation in such a way as to promote efficient use of energy by the consumer. Indeed, in certain states, such as Michigan, the state regulatory agencies have called upon the utilities to assist the consumer to make efficient use of energy, and have authorized the utilities to undertake certain types of financing and contracting for this purpose. The decision as to whether such programs should be implemented is, of course, one which must be made by the state regulatory commissions and by the utilities themselves; however, the early experiments show how utilities could use their marketing, customer service and advertising program to promote customer action for conservation.

Two principal actions are required to improve the efficiency of energy use (including electricity) at the point of consumption. First, a technical capability is required because the operation may be a technical problem, in fact, at times this is an intricate technical problem. In addition, most of the measures one might use to

Editor's Note: The term "consumer" is used throughout this Appendix to include operators of commercial buildings and industrial energy purchasers as well as householders.

* "The point of consumption" includes residences, commercial buildings and industry, which have been discussed by the other task groups.

improve efficiency at the point of consumption entail capital investments (e.g., reinsulation of attics, installation of industrial heat recuperators and so forth).

The utility system has already used its capabilities to help consumers take these actions; indeed, such assistance is the basic goal of many utility marketing programs.* One example is the program to persuade industrial consumers that by purchasing centrally generated power and at the same time using the technical customer service offered by the utility, they could use electricity more economically than by generating electrical power on site. Such programs were effective in increasing utility sales; but they also enhanced the efficiency of electrical power usage.

Today there are many utility customers, including householders, small businessmen and industrialists, who lack the special technical knowledge to determine where opportunities to improve efficiency might lie, or what conservation measures might best be applied in a given situation. Some utilities have already moved to assist such customers. Informational material on conservation distributed with household utility bills appears to have been helpful to consumers in many cities. Some utilities have offered to inspect individual homes to determine whether insulation, or other modifications might be effective. One utility has instituted a project to assist distributors of heat pumps to apply better maintenance procedures to heat-pump units in the field. Several utilities make thoroughgoing sample inspections of new construction and provide awards to builders who meet the standards of insulation, infiltration control and fenestration expected by the utilities.

These projects currently underway are but a few examples of present utility marketing efforts which have the effect of promoting efficient use of energy by the consumer. If the marketing and advertising arms of the utility system were to adopt nationwide conservation programs to assist householders, commercial building operators and industrialists to make more efficient use of energy, in the judgment of the Task Group, very significant savings could be achieved in the consuming sectors.

---

* In the utility system, one should include both the electric and gas utilities and the regulatory agencies established to safeguard the public interest in utility operations.