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ABSTRACT

This paper examines the causes and effects of the 1973 oil embargo imposed by OPEC. The author notes that since the embargo, little positive action has been taken to reduce American dependence upon a very limited and very expensive energy source. In order to achieve any degree of independence, it will be necessary to repidly expand coal and nuclear sources. The remainder of the paper discusses the role of the electric utility in these unusual and uncertain times and the role of the engineer in helping the utility fulfill its responsibilities. The responsibility of the utility is to provide a high quality of service at a reasonable cost to the consumer. The paper concludes with an examination of the employment patterns of Commonwealth Edison and discusses the traits and qualities young prospective engineers seeking employment with a utility should possess. (BT)

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NEW ENERGY ERA: SHORT TERM AND LONG TERM

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In the fall of 1973 the supply of oil to the United States from the middle east was abruptly curtailed by the embargo imposed by OPEC. The effects were immediate and widespread, and the words "energy crisis" suddenly became fashionable. Not only was the general public confused and annoyed, but many of those in responsible positions, and supposedly in the know, were also asking -- "What happened?"

In plain language, what happened was the end of a free ride on what was thought to be cheap and boundless energy from oil. For years, knowledgeable people warned us of an increasing inability of domestic oil to continue to match domestic needs. The rate of imports grew alarmingly, but domestic production remained relatively unchanged and our reserves dwindled at an accelerating rate.

The signs were ominous, but few paid heed. We continued to increase energy consumption at better than a 4% annual rate. The disturbing part of the energy picture was that about three-quarters of the energy being consumed came from the fuels with the lowest known reserves, oil and natural gas. Consequently, our dependence on petroleum and gas imports increased. By 1972 we were importing about 30% of our oil and nearly 5% of our natural gas.

In the year and a half that has passed since the embargo, little positive action has been taken to reduce our

dependence upon a very limited and very expensive source. The result is that our oil imports increased to 36% of our needs in 1974, the greatest total ever.

This is how the energy demand picture looks (Slide 1). In 1972 the nation's demand was about 72 quads, or 72 times ten to the fifteenth BTU's. One quad per year is roughly equal to a half million barrels of oil per day. At the historical growth rate of 4.3%, this will balloon to 125 quads by 1985. However, if the demand is tempered as expected by price effects and conservation measures, we will probably have a requirement of about 108 quads.

Again using 1972, the supply picture was as shown (Slide 2). Domestic oil and gas provided 63% of the total; imports another 15%; coal about 17%, hydro-electric 4% and nuclear about 1%.

In order to meet the anticipated demand of 108 quads in 1985, a possible allocation among the various sources is shown here (Slide 3). The significant point of this allocation is that the amount of domestic and imported petroleum and natural gas is almost unchanged from that of 1972. Virtually all of the growth has been absorbed by coal and nuclear. The share of these two sources has more than doubled, from less than 20% of the total to about 40%. This is an increase of about 30 quads.

In order to achieve even this degree of energy independence, it will be necessary for very rapid expansion of coal and nuclear sources. Unfortunately, the national climate isn't ripe for this expansion, and only a few people with national responsibilities recognize the problem.

The preceeding data was taken from the recent "National Energy Program" prepared by the Commerce Technical Advisory Board of the United States Department of Commerce (Slide 4). I used this report because I was more familiar with it than any other, but regardless which reliable report you choose, the answers are the same. The absolute values and the time frames may vary from one study to the next, but consistently, the implications are that we must rapidly expand our use of coal and nuclear power if we are to retain any semblance of energy independence and desireable economic growth.

I have excluded any reference to the "zero growth" programs, because I do not believe the proponents have adequately recognized the implications of such a policy. Today, our entire social and economic structure is very closely tied to relatively high energy consumption. This relationship could be relaxed in the long term, but any substantial change in the short run, certainly between now and 1985, would result in severe economic dislocations and subsequent drastic changes in life style. I believe a well managed growth is a much

more reasonable solution, and more acceptable to the nation in general.

Hopefully, the stage is now set for the remainder of this presentation, the role of the electric utility in these unusual and uncertain times, and the role of the engineer in helping the utility fulfill its responsibilities. Let me mention that I do not intend to play down the role of the other members of the energy industry. Their roles are equally important and much of the following applies to them; certainly in general, and in many instances, specifically.

The responsibility of the utility is clear -- continue to provide a high quality of service at a reasonable cost to the consumer. Unfortunately, this must be done under extremely adverse conditions. Namely:

A difficult financial climate

Reluctant regulatory commissions

Overly restrictive environmental requirements

Adverse public opinion

As a sample of the financial times (Slide 6) here is the decision of one large utility as it appears on the cover of its 1974 Annual Report. Inside the report, management went on to say, "Obviously these reductions will have a detrimental effect on our ability to serve the community in the future and will result in higher final costs."

All utilities have felt this financial crunch to

some extent. Rapidly rising fuel, construction, and money costs, coupled with inadequate rate relief have increasingly tightened the utilities' earnings picture. Without adequate earnings, not only will the needed expansion be impossible, but existing operations may have to be curtailed as well.

Regulatory commissions have been very reluctant to respond to electric utility requests for rate relief. Usually, many months pass before relief is granted, and then it is often less than needed. I know that the commissions themselves are in a difficult position. They are under constant pressure from the news media, legislatures and public to "hold the line." Nevertheless, if utilities are to play their role, the commissions will also have to bear their share of the "slings and arrows of outrageous fortune."

Environmental requirements have placed a tremendous financial burden upon the utilities and in turn upon the consumer. Recently, the Conference Board estimated that pollution control expenditures for manufacturing industries and utilities combined would be more than 10% of the total capital expenditures in 1974, and the trend is rapidly increasing. Furthermore, much of the recent increase in consumer electric costs has resulted from using high priced fuels that are necessary to meet environmental requirements. I doubt if the public realizes just how great the total cost is.

Certainly there are many justifiable expenditures for environmental protection. However, it is very important that they be justified on a cost-benefit basis. To date, virtually all of the environmental regulations have been arbitrary, and with little regard to cost. It is also essential that whatever environmental restrictions are imposed remain stable so that plants may be operated as designed, and not be subjected to costly shutdown and back-fitting unless necessary for health or safety.

Finally, in the area of public opinion, we face a massive problem. The recent rash of rate increases, the galloping fuel costs and the concern over health and safety have caused the public to take out their wrath on the electric utilities. Consider these words from the annual report of a very large eastern utility (Slide 7). Instead of a responsible government program to inform the public of the facts, it has been left to the utility to do it, often by way of the monthly bill.

Instead of supporting utilities, some officials have taken the opposite tack. For example, Alabama's Governor Wallace called the state ligislature into special session to consider the problem of high electric bills. Among other things, Wallace proposed the abolishment of the fuel adjustment clause and the creation of a people's utility counsel

to represent the public before the Public Service Commission. This is an unusual action because that Commission was established to protect the consumer.

Furthermore, the head of the state branch of the American Civil Liberties Union proposed a state take-over of Alabama Power. Apparently he believes state ownership will magically bring world fuel prices into line, and will roll back construction and operating costs to the happy days of a few years ago.

In spite of all these problems, or challenges as the management consultants like to call them, we must plug along and build new generating capacity, extend transmission lines, construct new substations and continue to serve a growing load.

From our viewpoint, there is only one way to go. In the words of Thomas G. Ayers, Chairman of Commonwealth Edison Company, (Slide 8) nuclear power and coal are the only real answer. Both are in abundant domestic supply; both can be used immediately with existing technology; and both are well within reach of the consumer's pocketbook. No other energy sources hold such current promise.

I know there are many proponents of various exotic sources of electric power such as solar thermal, windmills, ocean thermal gradients and photovoltaic conversion. In

fact, some of you in this room may be enchanted with one or more of them. However, regardless of the possible future worth of these sources, none will make a noticeable impact upon our energy needs in the next 10 to 20 years, and perhaps later, because of technological immaturity or unsatisfactory economics or both.

In light of all this, there will be a great need for engineers by electric utilities and the energy industry as a whole. The report "U.S. Energy Prospects - An Engineering Viewpoint" prepared by the National Academy of Engineering in 1974, estimated requirements for engineers in the energy industry as shown (Slide 9) if we are to meet the 1985 energy needs mentioned earlier. This is a 40% increase in a seven year period.

This increase may be difficult, if not impossible, to achieve because the number of full-time engineering undergraduates and graduates has been decreasing in the last six or seven years. The one bright spot is the large increase in freshmen engineering students in the fall of 1974.

The electric utility business has been hiring engineers of all types in record numbers in recent years. The pause in utility hiring in the last year or so has resulted from what we believe are temporary conditions -- delays in utility expansion plans because of load growth

uncertainties and financial problems, and what is believed to be a short-lived slowdown in the economy.

However, Commonwealth Edison is convinced that load growth will recover. Not only most of the load we had previously expected, but an additional piece of growth resulting from substitution of electricity for fuels that are becoming scarcer and high priced.

Historically, Edison, like other utilities, has employed a large number of engineers. At the end of 1974, we had nearly 1200 engineering and related graduates, many of whom had been hired recently as shown on this slide (Slide 10). Notice the increasing trend in recent years. In the last five years, we have averaged a net gain, allowing for those who left us, of nearly 100 per year. 1975 is following much the same course as the last few years. We are convinced that we must build for the future and we can't do it overnight.

You may also note that the median service year is 1967. Half of our engineers have started since then, so we have a relatively young staff.

The mix of recent hirees looks like this (Slide 11). You will notice that we are somewhat heavy on electrical and mechanical oriented graduates because of the nature of our business. But, we have needs for others including civil, chemical, nuclear and metallurgical. Of the 492

total, 56 have Master's Degrees and 9 have Doctorates. Half of the advanced degrees are in nuclear engineering.

We strive to give our people a wide variety of training within the company. Our experience has been that broadening is extremely important for a utility engineer, so that he will be conscious of the other company operations that could be affected by a decision made in his area.

The development of engineers starts immediately after hiring. The new graduates are assigned to a six-month program under which they will be given three or four short assignments in different departments. This gives us a chance to evaluate them and for them to develop some preferences. During that time, they also attend a series of one-day orientation meetings at which many phases of company operations are discussed including financial, engineering, marketing, Division operations and so on.

Upon completion of the Graduate Orientation Program, the engineer receives his first permanent assignment. Permanent is a misnomer because seldom does he spend more than a few years in any assignment until he has had exposure to the work in at least three or four departments. A typical electrical engineer might work as a field design engineer in one of our Division offices, then in distribution design and planning, and later in bulk power work in System Planning, all in a six or eight year period.

A mecha[illegible]al engineer might work in a nuclear or fossil generating station, then in station design work and later in Production Control and Efficiency or Station Construction in the same six or eight years.

In addition to being well rounded, our engineers are broadened in other ways. Many are assigned to financial, marketing, computer and administrative positions. In my own career as an electrical engineer, I have had four engineering assignments, two financial and three operating and administrative in 15 years. Some of those assignments were related so I didn't do quite as much hopping around as it looks. There are many others with similar diversity.

Years ago, a new utility engineer might expect to be nursed for many years before being weaned. But as I mentioned a few minutes ago, we have a relatively young staff. Consequently, a number of young engineers hold very responsible positions. A few examples are:

> An electrical engineer with 10 years service is now Operating Manager of one of our Chicago Divisions and is responsible for the activities of 430 persons engaged in engineering, construction and operations.

A mechanical engineer with four years of service is overseeing the design of a coal gasification project at one of our generating stations.

A young woman civil engineer with four years service recently completed an assignment in which she was responsible for analysis of sites for future generating stations. One week ago, she was assigned to the management staff at our Will County Generating Station.

All told, our engineers are engaged in virtually every phase of planning, design and operation of nuclear and fossil generating stations, of extra high voltage transmission lines and of distribution stations and circuits. In addition, they become involved in many exciting research projects such as high voltage, direct current underground transmission, compressed air storage, coal gasification, breeder reactors, and underground pumped hydro.

A recently completed, and very successful, Edison R and D project was the forced cooling of high voltage pipe cables. This technique has enabled us to increase the ratings of our 138 kv pipe cables by a minimum of 50%. This is not peanuts, considering that similar new lines would cost about $1,000,000 per mile. We will also use

this on a new 345 kv line that is planned.

These are only a few of the ways we use the young men and women you send to us.

Now, I would like to discuss something that relates directly to you -- what we look for in hiring young engineers. A solid foundation in the basics is a must, but in addition,

1. We like our electricals to have a 60 hertz background. Unfortunately, many come to us with little knowledge of transformers, rotating machines, three phase circuits and symmetrical components. We now have our own in-house power systems course to teach these fundamentals. We believe that because energy is becoming more important by leaps and bounds, these fundamentals should be integrated with the regular engineering cirricula at the university level.

2. A computer background is also useful because so many of our calculations have been automated including power flows, transient analyses, emission calculations, nuclear fuel analyses,

production cost models and so forth. Furthermore, at most locations, our engineers have terminals that can access the computers downtown.

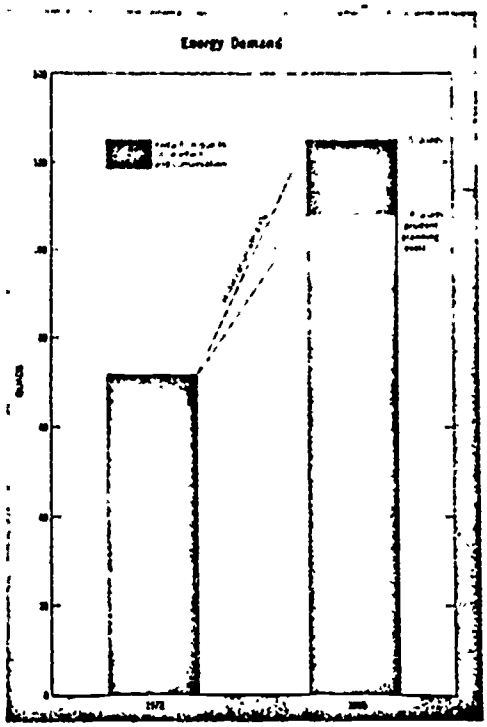
3. The ability to communicate orally and in writing -- especially the latter -- is a must. Most proposals and reports are transmitted upwards, and nothing is worse that sending your boss a crummy memo. I am not concerned so much about the "woulds" and "shoulds" and "coulds," but I do get annoyed with a rambling, inaccurate, poorly structured document.

4. We also look for a willingness to develop a broad interest in many facets of the business. Our engineers cannot be narrow, because in addition to engineering, they become involved in environmental affairs, marketing, public relations and economics. Many of our engineers are called upon to testify in a variety of regulatory hearings and to deal with a number of

public agencies. A broad background is immensely important under those circumstances.

In conclusion, the nation, the energy industry and the electric utilities are in the midst of very difficult times. But they are also very challenging times, and we need many good engineers to solve the problems we face. Not only the known problems of today, but the problems of tomorrow and the tomorrows thereafter. The educational institutions have a tremendous task facing them if they are to provide the quantity and quality that are needed -- needed to provide a very vital service to society.

1.



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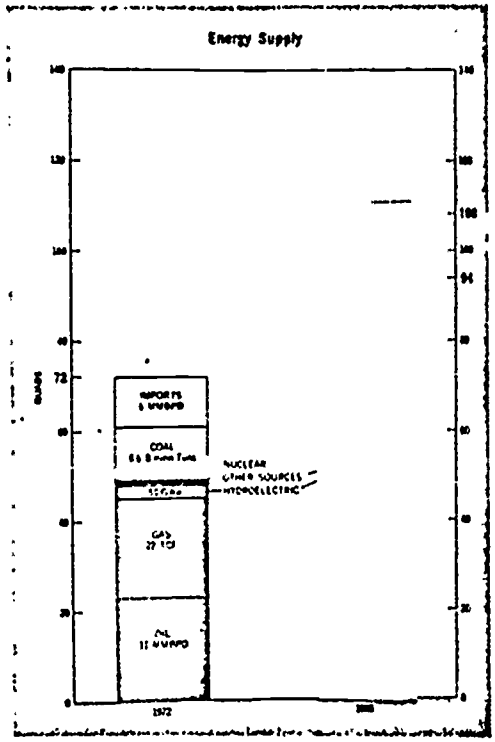

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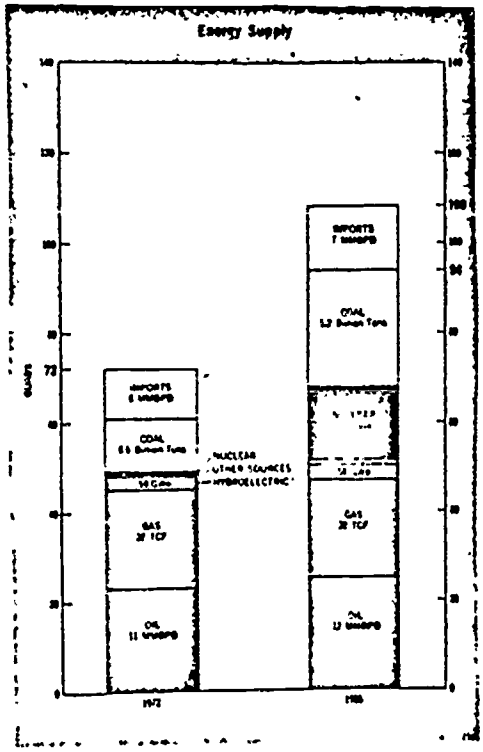

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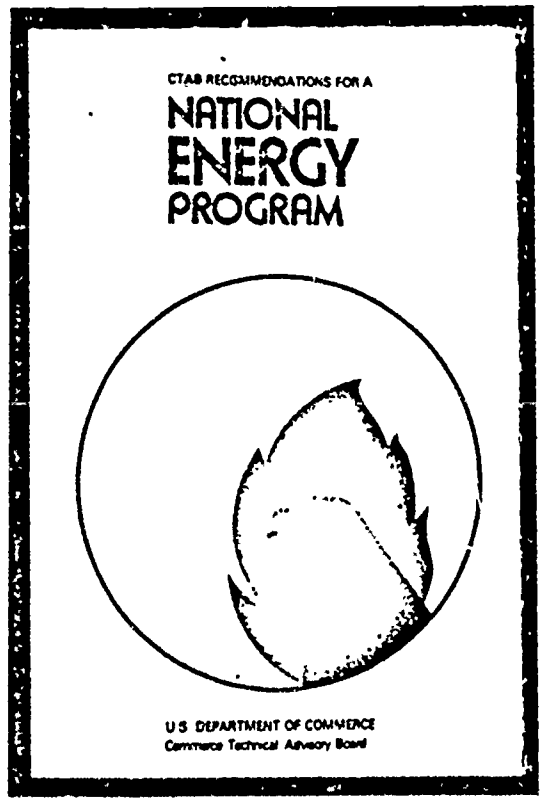


5.

DIFFICULT FINANCIAL CLIMATE

RELUCTANT REGULATORY COMMISSIONS

OVERLY RESTRICTIVE ENVIRONMENTAL REQUIREMENTS

ADVERSE PUBLIC OPINION

1974 Annual Report

Because we are in a difficult financial situation, we have taken severe internal cost-cutting measures, have reduced our total work force and have halted our field construction program

6.

"No one loves the messenger who brings bad news. Government has, however, left the utility in the unenviable role of the messenger. The public's perception of the energy problem has been made manifest in attacks on electric utilities, and public attention is being diverted from the Nation's real problems by assailing the utilities."

7.

'The best way to meet the requirements of our economy for electricity is to concentrate on nuclear power and coal'

By Thomas G. Ayers
Chairman and President
Commonwealth Edison Company

Project Independence hearings conducted throughout the country by the Federal Energy Administration August 6 through October 10, 1974 were aimed at developing a strategy to lessen U.S. dependence on foreign energy sources. The following is based on Mr. Ayers' testimony at the hearings held in Chicago on September 9, 1974.

In our view, the best way to meet the

Risk of Fatality by Various Causes

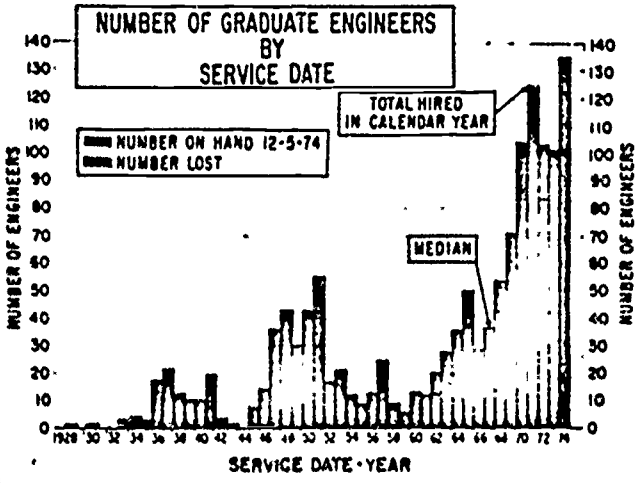
Accident Type	Individual Chance Per Year
Motor Vehicle	1 in 4,000
Falls	1 in 10,000
Fires and Hot Substances	1 in 25,000
Drowning	1 in 30,000
Firearms	1 in 100,000
Air Travel	1 in 1[illegible],000

8.

ESTIMATED ENGINEERING MANPOWER IN ENERGY INDUSTRY

	1973	1980
ELECTRICAL	26,110	34,940
MECHANICAL	17,320	26,350
CIVIL	15,640	24,350
MINING	7,920	9,830
CHEMICAL	7,410	9,240
TOTAL	74,400	104,700

9.



10.

COMMONWEALTH EDISON
ENGINEERING & RELATED GRADUATES
HIRED FROM 1970 - 1974

ELECTRICAL	182
MECHANICAL	98
NUCLEAR	27
PHYSICS	27
CHEMICAL	24
CIVIL	24
METALLURGICAL	10
GENERAL & OTHERS	100
TOTAL	492

11.