Nuclear
Energy

DOE/NE-0061

Nuclear Energy Economics

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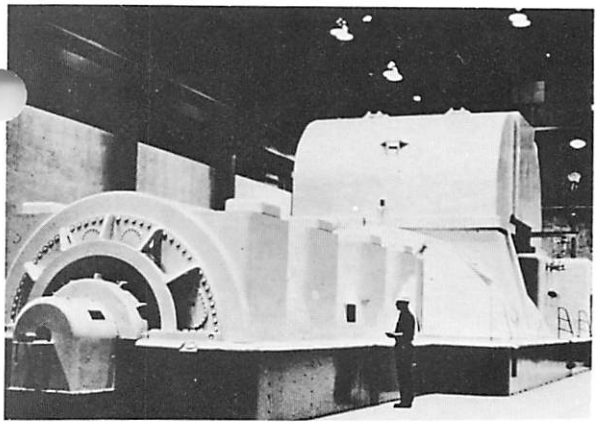
ECONOMICS AND NUCLEAR ENERGY

Electricity is produced, bought, and sold in today's economy like other commodities. It is a form of energy that is uniquely suited to modern America's needs. Because it can be made using a variety of fuels, the price of electricity depends mainly on where and how it is produced. Properly used, uranium is one fuel that can help supply this country with safe, clean, and economical electrical energy.

THE ELECTRICAL CONNECTION

America uses 2,300,000,000,000 kilowatt-hours (kWh) of electricity each year to run its homes and industries. To generate this much electricity using people to turn generators, every person on the Earth would have to work 24 hours every day at the task. There could be no lunch breaks, sleeping, rest periods, or strikes.

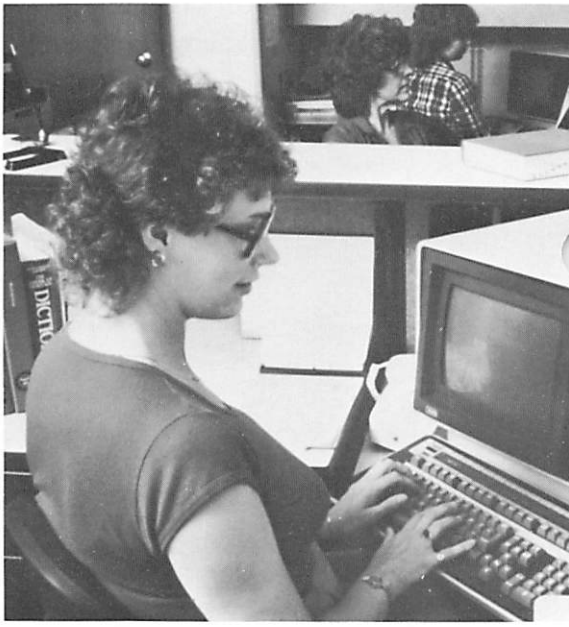


Huge turbo-generators convert the energy in various fuels into the electricity vital to America's economy.

Of course, electricity is not generated in this way. America produces electricity by converting the energy in primary fuels into mechanical energy to turn generators in a system of over eleven thousand dams and powerplants nationwide. This tremendous effort is taken because, as an energy form, electricity is clean, easily transported, relatively inexpensive, and extraordinarily versatile.

In many ways, America's economy is linked to an adequate supply of electricity. Most households and businesses would come to a standstill without it.

Electricity is the energy form used by Americans to illuminate, communicate, calculate, and refrigerate. And while the use of other energy forms has leveled off and even declined since 1974, the use of electricity continues to grow. Historically,



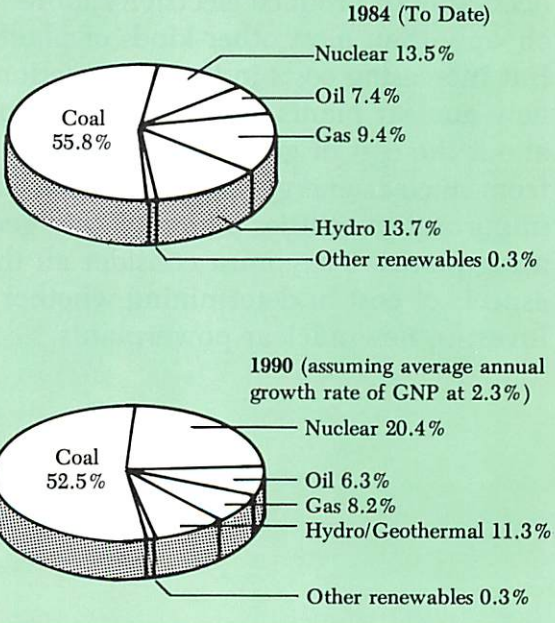
The computer is a powerful tool which depends on a reliable supply of electricity.

the increase in electrical demand has paralleled our nation's output of goods and services. Many experts believe that this trend will continue as electricity is substituted for other energy forms.

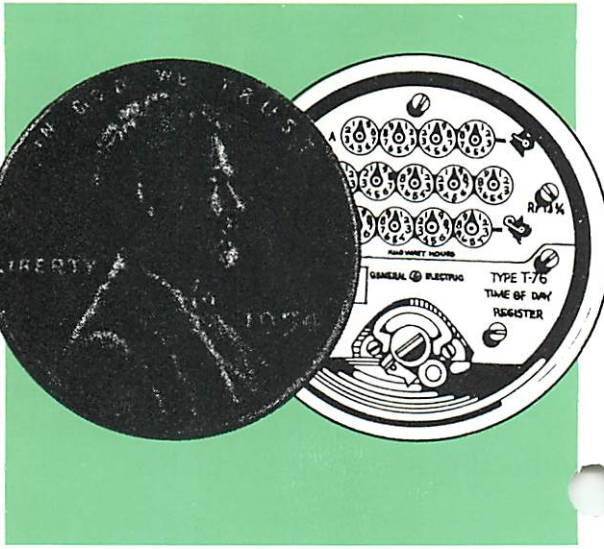
One important aspect of electricity is that it can be produced using a variety of energy sources. In addition to hydropower, America's utilities generate electricity using primary fuels like coal, oil and natural gas. At nuclear powerplants the primary fuel used is uranium. Otherwise, nuclear powerplants are quite similar to conventional powerplants in the way they operate.

Nuclear energy is a relative newcomer to the energy supply mix. Even so, it has been in commercial use for over 30 years and now provides over one-eighth of the electricity we use. That share will continue to grow as plants now being built begin to produce electricity over the next decade. New technologies, including solar and fusion energy, hold promise for future electrical production. Today, however, coal and uranium are the major fuel choices for utilities planning to build large, efficient new powerplants.

ELECTRIC GENERATION BY PRINCIPAL ENERGY SOURCES (U.S.)



Sources: Energy Information Administration, Electric Power Monthly, *January 1984, and Department of Energy,* Energy Projections to the Year 2000, *August 1982.*



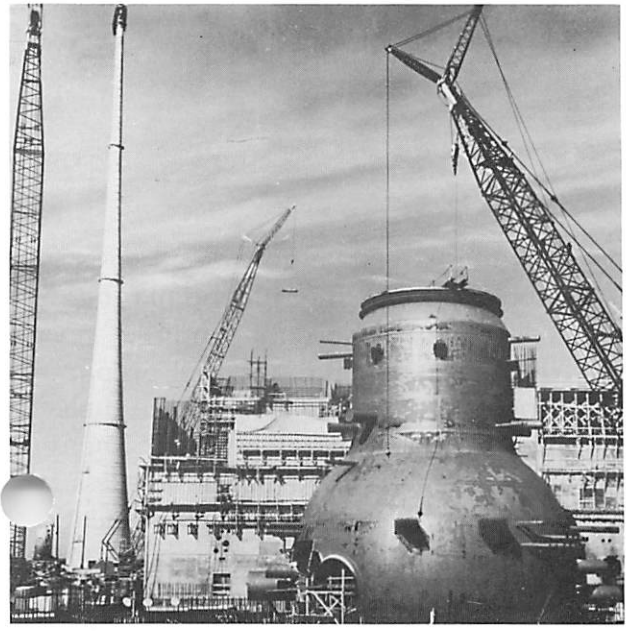
Nuclear powerplants have historically been able to produce electricity more cheaply than most other kinds of plants. But increasing costs in the construction of new nuclear plants have raised questions about the cost of generating electricity from nuclear energy. Such questions are important to utilities planning new generating plants. They must consider all the aspects of cost in determining whether to invest in new nuclear powerplants.

COST FACTORS IN PRODUCING ELECTRICITY

The cost of producing electricity falls into three categories:

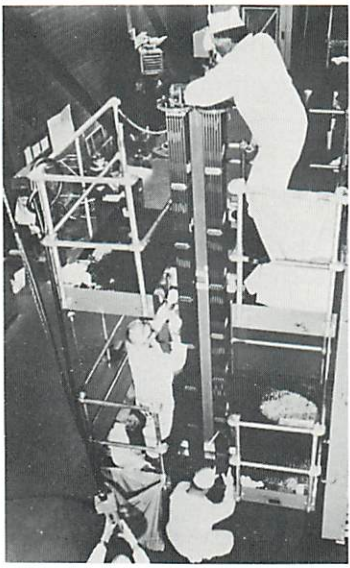
— Capital costs
— Fuel costs
— Operating costs

- Capital Costs - This is the amount of money required to build a new powerplant. Various factors affect the capital costs of new plants. One, for example, is size. Larger plants are understandably more costly to build than smaller ones. However, larger plants may be able to produce electricity more efficiently and therefore at a lower cost per kWh. Another important factor is complexity. More complicated systems require more time and quality assurance during construction, and nuclear



Capital costs represent the expense of building a new powerplant.

powerplants are among the most complex of all civil engineering projects in the private sector. A third important contributor to capital cost is interest, or the expense of borrowing the money to pay for the actual construction of a new plant. The average capital cost for a 1000 megawatt electric (MWe) coal powerplant today is over $1 billion. Capital costs for nuclear plants are, on the average, 50 percent higher than for coal plants.



Fuel costs at a nuclear powerplant account for about 1/5 of the cost of the electricity it produces.

- Fuel Costs - These include all costs associated with fuel for the plant. They must take into account mining, transportation, and any fuel preparation, and disposal costs. Since fuels have different energy contents, measurements of cost per pound are less informative than cost per unit of heat. Nuclear fuel is a good example of this. Though uranium is expensive, a little bit goes a long way. A typical nuclear

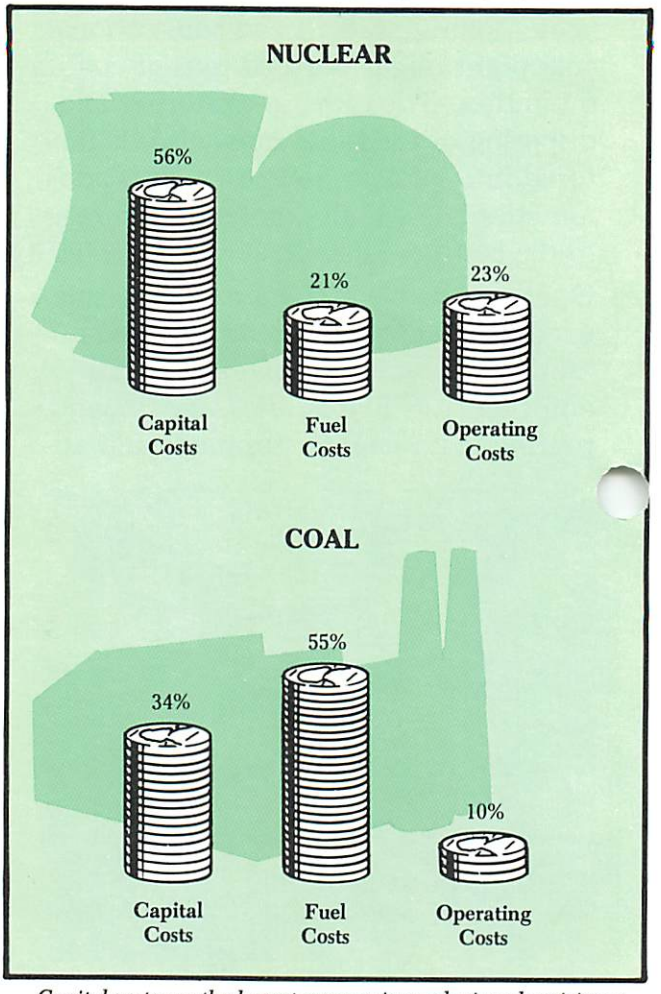
plant uses only about 30 tons of fuel per year. A comparably sized conventional coal plant might burn 30 tons of coal in 6 minutes. The expense of storing and disposing of used fuel must also be factored into nuclear fuel costs. This adds something less than one-tenth of a cent to the cost per kilowatt-hour of electricity.

- Operating Costs - These represent the overall expense of running and maintaining the facility. Included are all non-fuel costs like salaries, repairs and routine maintenance, supplies, and ad-

Operational costs include salaries and maintenance.

ministrative costs. Repair costs on large systems can be expensive. In addition, utilities must sometimes purchase replacement power from neighboring utilities when plants are out of service.

Comparison of Costs by Category



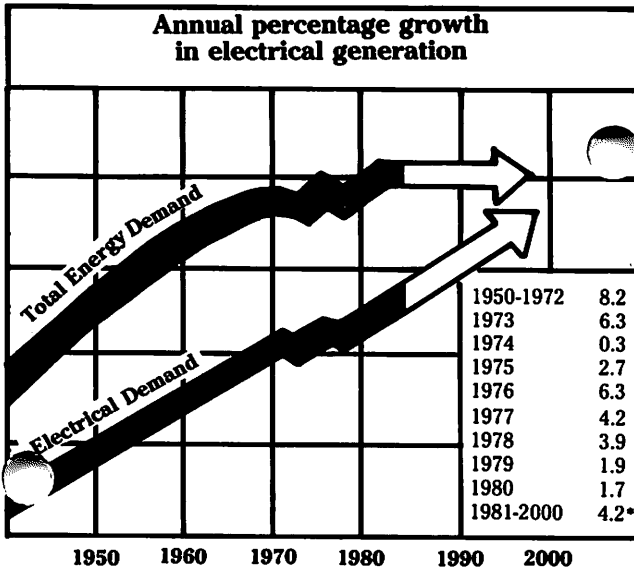
Capital costs are the largest expense in producing electricity at a nuclear powerplant, while fuel is the largest expense at a coal-fired powerplant. On the average today, total costs are about equal.

It is the total of the estimated costs from these categories that is important to a utility in deciding what type of plant to build. Because utilities look for the best return on their investment, and because the public expects reasonable power ra these decisions are important ones. And since new powerplants take from 5 to 15 years to complete, utilities must live with their decisions for quite some time.

UNCERTAINTIES IN PLANNING

Demand Projections

Anticipating the amount of electricity that will be required in 5, 10, or 15 years is tricky. This is clearly illustrated by the experience of the last 15 years. Growth in total energy demand throughout the 1950s, '60s, and early '70s increased at a steady 10 percent per year. During this time the demand for electricity was growing at over 8 percent annually, and utilities planned new generating plants accordingly. Beginning in October 1973, a series of largely unforeseen events—an Arab oil embargo and a revolution in the Middle East producing gas lines and a sudden shift toward conservation—drastically revised America's energy forecasts. Today, experts project that electrical demand through the end of the century will grow at only half the rate experienced in the years prior to 1973.



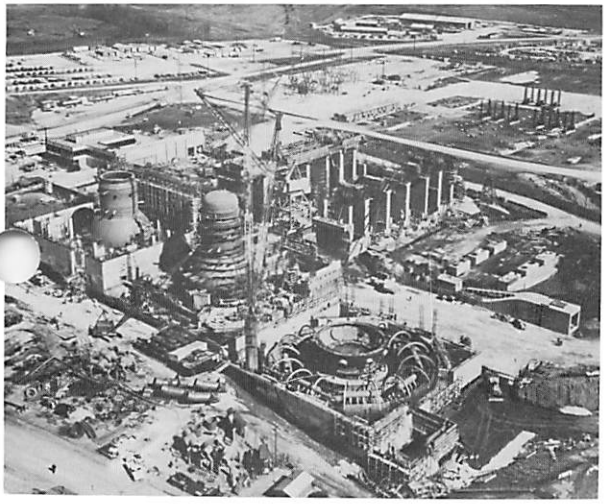
*Projected, assuming intermediate economic growth.

Interest Rates

Like demand, interest rates on loans have changed a lot in the recent past. Utilities typically borrow hundreds of millions of dollars to finance new plants. Until the early 1970s, interest rates were running at less than 5 percent. When rates rose sharply to record levels in the mid-1970s, the cost of borrowing money for a new plant often accounted for nearly half of its total price tag.

Delays

Whether due to management errors, legal action, or new regulations and requirements, delays in construction of a new plant drive the cost up dramatically. It is not uncommon for such delays, when compounded by high interest, inflation,



Delays in construction at new powerplants can increase costs dramatically.

and the cost of replacement power, to cost the utility, and ultimately the rate payers, close to $1 million per day. While such delays have been common in the construction of many types of power-plants, nuclear powerplants have been hardest hit. This is because construction costs make up such a high percentage of their total costs, because regulations for nuclear plants have often changed substantially during construction, and because some utilities have found themselves unable to adequately manage projects on such a scale.

MEETING DEMAND

Why are utilities interested in building large powerplants in the first place? The simple answer is that it's generally less expensive to build one large plant than several smaller ones. In actual practice, utilities operate a variety of types and sizes of plants to meet specific needs and assure adequate supply.

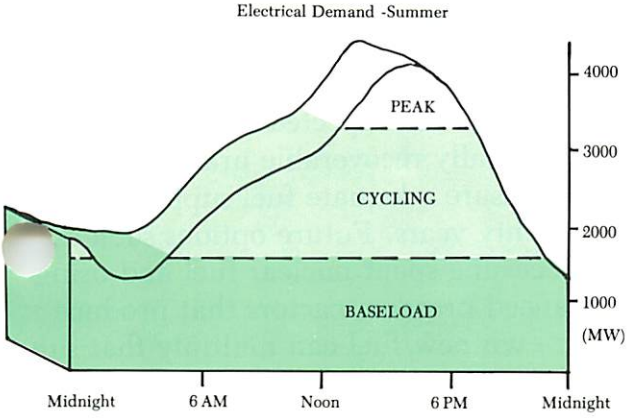
TYPES OF GENERATING PLANTS

Baseload - Electrical demand fluctuates throughout the day, week, and year. However, a certain, minimum amount is used by customers all the time. Because this "baseload" demand remains fairly constant, it is typically supplied by large (500-1100 MWe) nuclear or coal plants that run at full capacity day and night.

Cycling - Each day demand rises and falls as people go to work, businesses open, air conditioning is turned up, and factories gear up production lines. To meet these daily fluctuations in demand, smaller coal, hydroelectric, oil, and natural gas powerplants are used. These cycling plants can be operated at varying levels without a major loss in efficiency.

Peaking - During periods of highest electrical demand, such as during a heat wave, utilities use relatively small plants (20-50 MWe) that can be started up quickly. Such peaking plants typically power their turbines with expensive oil or natural gas, so they are used only for short periods.

By operating plants as they are needed, starting with the most efficient baseload plants, utilities adjust their production to meet demand. Typically, about two-thirds of a utility's electricity is generated by baseload units.



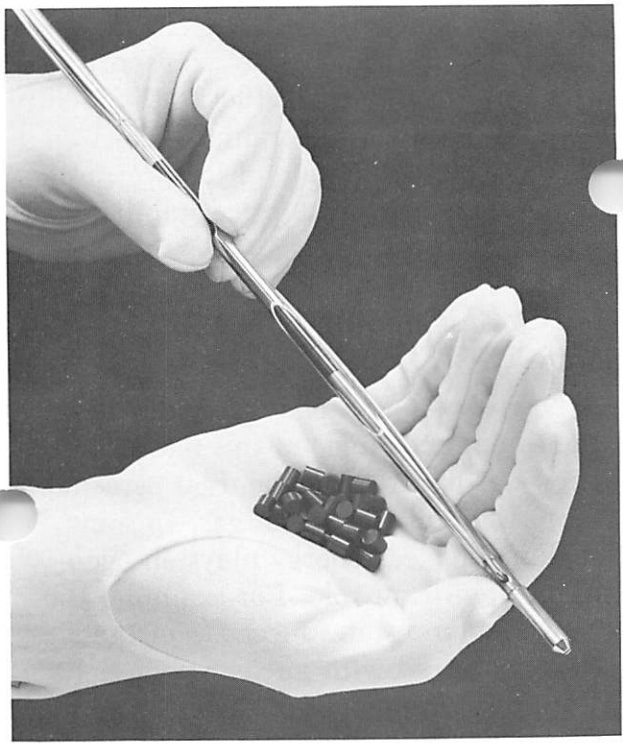
Baseload plants usually operate 24 hours a day. As electrical demand begins to climb each morning, utilities also start up ***cycling*** *and* ***peaking*** *plants to supply needed power to customers.*

The role of nuclear powerplants in the electric grid is in helping meet baseload demand. Nuclear powerplants are well-suited for this application because they run most efficiently at a constant, high level of output.

URANIUM AS FUEL

While fossil fuels such as oil, coal, and natural gas are essential raw materials in the production of fertilizers, medicine, plastics, and textiles, uranium is of little value except in the production of electricity. The United States and Canada have substantial reserves of uranium. Combined with today's more efficient reactors and lower than expected energy demand, economically recoverable uranium deposits assure adequate fuel supply for fifty to seventy years. Future options such as reprocessing spent nuclear fuel and using advanced breeder reactors that produce their own new fuel can multiply that supply by a factor of 60 or more.

Coal, oil, and natural gas are more than fuels for powerplants. They are essential raw materials in the production of medicine, fertilizer, clothing, and household products.



Uranium contains highly concentrated energy. It is of little value except as a fuel for electrical production.

Uranium requires several preparation steps before being used in powerplants. While mining and milling processes are comparable to those used for other minerals, uranium enrichment is unique. T process concentrates the amount of useable fuel in the natural uranium and requires special technology. The United States has the world's largest enrichment capacity and is developing new and more efficient enrichment techniques for the future. Because uranium contains such concentrated energy (a thimble-sized fuel ellet has about the same energy as a ton of coal), fuel can be used to produce electricity for 3 years before being replaced.

This is important to a utility since there is much less cost involved in transporting this smaller amount of fuel to the facility. As a fuel, therefore, uranium offers an attractive combination of long-term domestic availability, price stability, and low related costs.

NUCLEAR ENERGY IN THE U.S. ENERGY MIX

Nuclear energy today provides about the same percentage of this nation's electricity as hydropower, and 50 percent more than oil or natural gas. In some regions, nuclear energy plays an even more significant role. For example, the New England states meet 1/3 of their electrical need with nuclear power. In Vermont, 78 percent of the electricity comes from nuclear power.

The cost of electricity generated by nuclear powerplants can vary widely between regions, utilities, and even individual plants. Nuclear energy can range from one of the cheapest to one of the most expensive forms of electrical production, depending mainly on the capital cost of the plant.

DOE supports the development of all energy resources and their contribution to the U.S. energy mix. Along with other resources, nuclear power can make an important contribution to a reliable, adequate supply of electrical energy for America.

DOE/NE-0061
Dist. Category UC-2

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