# Can New Resources Fill The Energy Gap?

Ken Owens
Editor

It took about a year for the consumer to forget, or ignore, the impact of the 1973 oil embargo. While industry continues its successful application of various techniques to conserve energy to produce goods and services, the consumer has long since reverted to energy-wasting habits.

As early as January 1974, the demand for residential electric energy started upward; by fall the 55 mile per hour speed limit was forgotten by the majority and now the 60 or more cent a gallon gasoline is bought off-handedly.

The consumer apparently has set aside energy conservation for creature comforts.

Can it last? Will another embargo be the only mechanism that will force a change in the consumer's generally wasteful use of energy? Or can technology solve the problem to provide all the energy the nation seems to want—and expect?

Without a national policy that provides direction to our energy development and guidelines for its proper use, there is no solid answer to these questions. One can only look at where we stand now and assess what the future might hold.

Recently, Roger J. Sherman, president of Ebasco, spelled out where we are in our energy dilemma, while the potential for more energy in the future was reviewed by Dr. M.L. Sharrah, senior vice president for Research and Development at Continental Oil.

### Where Do We Stand?

Roger Sherman claims the problems concerning energy will continue, and whether the situation improves or worsens depends on some complex factors. "For example," Sherman said, "the role of energy consumer and that of energy supplier will be greatly influenced by the nation's handling of a complex matrix that includes our environmental goals, economic development, social direction plus the national and international growth patterns. How well the nation addresses itself to these problems today also can impact our economic, social and political health."

In this century, economic growth is tied to the availability of electricity, Sherman noted. "If electricity gets into trouble, so will the economy of our nation and that will affect our standard of living and our ability to compete internationally."

He said since 1973 the nation has been run through a rolling energy squeeze, experienced economic calamities and been forced to contend with technological and economic priorities spawned by ill-advised environmental and political actions. And along with these difficulties has come a "crisis of the year," every year. With each new crisis it's then suggested that international sources of energy be ignored so the nation can go its independent way, squeezing energy from the tides, milking the sun, spinning with the winds, and trapping steam from the earth. Sherman said these are unrealistic concepts for any immediate energy requirements.

To demonstrate why these concepts are unrealistic for near-term use, Sherman used three charts. With the first chart, he pointed out that electric utility generation will expand from 1.9 to 2.6 trillion kilowatt hours in the next few years—an increase of 40 percent. The chart also shows the utilities will still be using substantial amounts of coal, oil and natural gas.

With the second chart, Sherman showed how the cost of fuel has skyrocketed. Pointing out that there is no reason to expect these fuel costs to come down at any time, Sherman noted that now, more than ever, conservation is essential to our economic health.

To show the impact across the nation, Sherman used the third chart which illustrates that all sectors of the country have been hit equally hard by fuel cost increases. Combined with these high fuel prices, Sherman noted there has been considerable money spent on pollution control systems, and he does not expect the requirements to spend more money to ease off. The electric utility industry spent over $1.5 billion in 1975, Sherman said, with $1.2 billion spent on air pollution, the rest on water pollution abatement.

Sherman went on to say that faced with these realities, the public, regulators, utilities and industries sense that time and energy are short, but not being in acute crisis, there is danger that makeshift energy policies combined with an economic upswing will lull some of our energy apprehensions. Sherman says it's essential that this not happen because it takes a long time to explore for and then develop and distribute energy resources. "There are no instant oil or gas wells, coal mines, pipelines, transmission lines or nuclear installations. It is essential that we all look forward to plan for and meet inevitable shortages and climbing costs."

Looking then to the future, what can we anticipate as new sources of energy?

### Five Alternatives

Dr. M.L. Sharrah of Continental Oil Co. says there are five alternative sources of energy closest to commercialization—tar sands, shale oil, coal gasification, methanol from coal and coal liquefaction. Sharrah noted that one plant for extracting oil from tar sands is operating (unprofitably) in Canada, with a second plant under construction. This technology, he says, is obviously the nearest to commercialization. Coal liquefaction is behind all the others—the technology has not been demonstrated on a prototype scale to date.

The real drawbacks for the front runners are economic rather than technological. Sharrah noted that the investment in plants and technical developments is huge, making the cost of the alternative fuels very high compared to conventional fuels. The return on investment would be too low, he said.

The price of the five fuels, Sharrah explained, would be equivalent to oil priced in the $24 to $27 range. That's much too expensive to compete with oil at its present $11 to $13 per barrel cost.

Specifically, Sharrah appraised the five alternative fuel sources as follows:

### Oil From Tar Sands

Although there are an estimated 300 billion barrels of recoverable oil in tar sands, less than 10 percent can be surface mined. Most deposits must be recovered by using steam or fire to make the bitumen thin enough to flow out of the earth.

The Athabasca Oil Sands Project Group, which holds leases on 100,000 acres in the tar sands area, is assessing the investment in money and manpower needed to separate out the oil.

"Based on what we know of plant construction and operating costs, our estimate of the price of crude from oil sands is about $27 a barrel," Sharrah notes.

### Oil From Shale

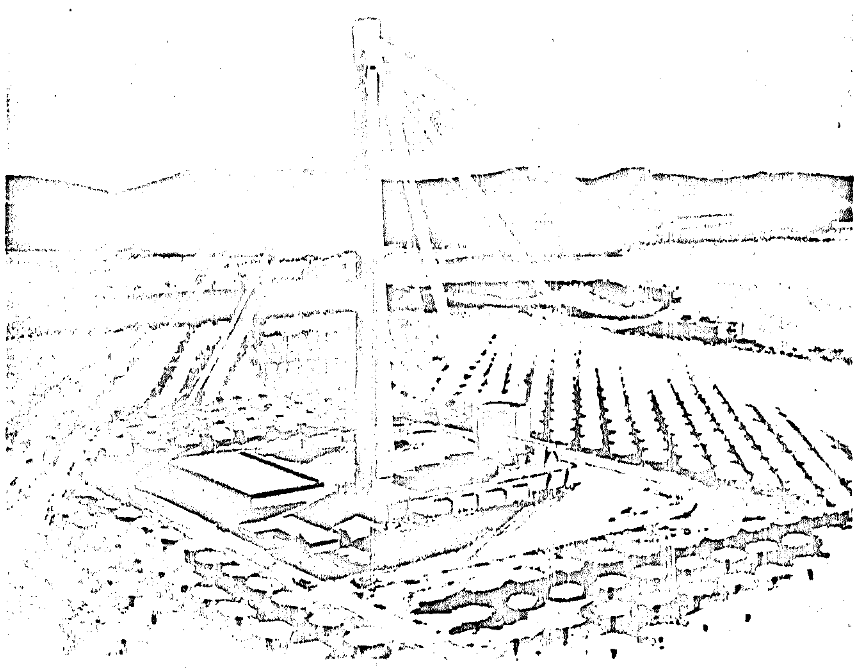
Shale deposits in the U.S. Rockies contain from 600 billion to 1 trillion barrels of extractable oil—enough to last the nation 100 years or more at present rates of consumption. The shale contains a waxy hydrocarbon called kerogen which when heated to 900 F, liquefies and can be collected and condensed into crude.

A pilot oil shale project in Colorado was suspended in 1974 because the process was uneconomical. Reliable data on the probable costs show oil from shale would run $24 a barrel in 1975 dollars.

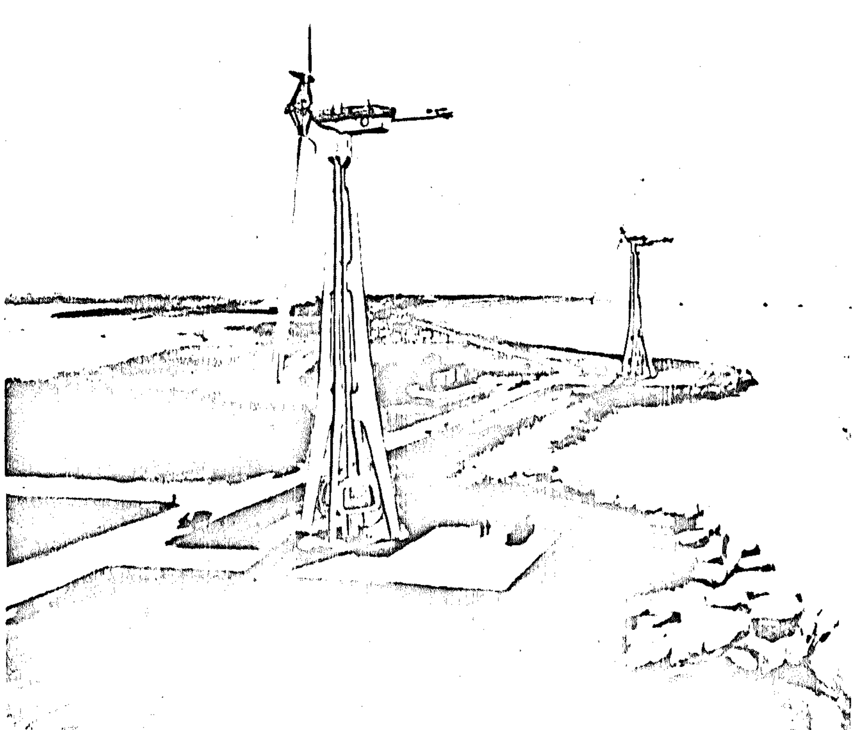
### Coal Gasification

Low-heat-content gas has been made from coal for a long time. Much of the United States and Europe had no other gas until after World War II, when natural gas became available.

"U.S. coal is abundant, but much of it is in the western part of the country, far



SOLAR ENERGY can heat buildings and supplement hot water heating, but direct conversion of sunlight to electricity requires considerable improvement in the efficiency and cost of photovoltaic cells. Solar panels, shown here, are too expensive and take up too much land area to be a practical answer, say most researchers.



WIND ENERGY, although free, has little chance of providing much energy for future applications. Building codes, height restrictions and the variable nature of winds, tend to lessen its role in the energy resource picture, although work continues on the technology.

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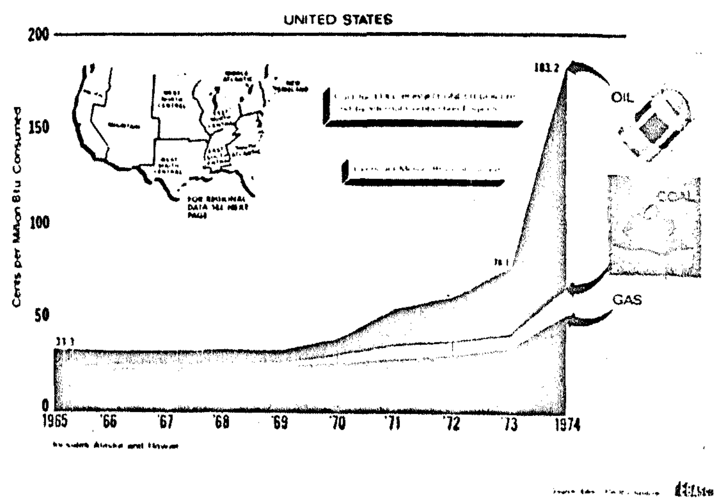


## ENERGY SOURCES FOR ELECTRIC UTILITY POWER GENERATION

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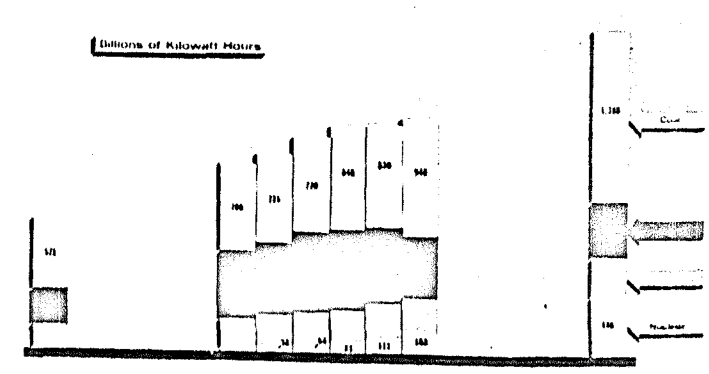


## COST OF FUEL BY REGIONS

**Total Electric Utility Industry**

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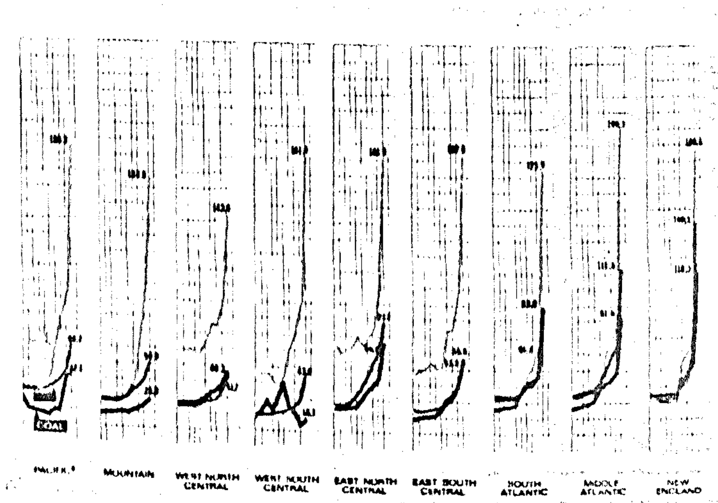


from large population centers," explains Sharrah. "This coal can be converted into methane gas and shipped through pipelines as a substitute for natural gas. However, our estimates are that gas from coal, on an energy-equivalent basis, would cost $24 a barrel, or roughly twice the current price of imported oil and about nine times the price of regulated new interstate natural gas."

### Coal Liquefaction

Before World War II, Germany and Great Britain constructed plants to produce a liquid synthetic oil from crushed coal. The operations were limited in size, however, and the oil product was very expensive. Although liquefation has never been undertaken on a commercial basis in the United States, there have been several pilot research projects. An oil-from-coal plant is operating in South Africa and, by the early 1980s, 40 percent of that nation's gasoline may come from coal.

As with coal gasification, liquid fuel from coal currently would cost about $24 a barrel, Sharrah estimates.

### Methanol

Methanol, or wood alcohol made from coal, is easily stored and transported. It can be burned in internal combustion engines, run gas turbines, and might also serve as a jet fuel.

Researchers have tested the colorless liquid as a gasoline substitute. By converting two automobiles to burn methanol and driving them thousands of miles, scientists learned a great deal about the potential of the fuel—and the problems of using it. Methanol burns cleaner and more efficiently than gasoline. On the other hand, it has only half the energy content of gasoline, which means twice as much methanol would be needed to power a car the same distance as gasoline does. Because the capital requirements for methanol production are about the same as for coal gasification, on a Btu-equivalency basis with oil, the price of methanol also would presently be $24 a barrel.

### Help From Technology?

Deeply interested in the possibility of technological breakthroughs that might cut the costs of synthetic fuels from tar sands, shale oil, or coal, Sharrah is not overly optimistic.

"Improved technology," he says, "will probably provide only slight improvement in the economics. Furthermore, lower raw material costs, capital requirements, or operating costs seem unlikely."

Sharrah is even less enthusiastic about a second group of energy alternatives—solar power, breeder reactors, nuclear fusion, and geothermal energy. He ranks these considerably below tar sands, shale oil, and coal gasification and liquefaction, in terms of commerical development. He tells why:

"Although there is the possibility of significant technical improvements with this second group of energy sources, some of them may not ever be commercially operable," he says. "And even if there are dramatic technological breakthroughs, it will be many years before we can expect significant contributions from them to energy supplies."

Here is his assessment of the likelihood of profitable commercialization of these new energy sources, along with some of the technological, environmental, and political problems they face:

### Breeder Reactor

Despite its potential economic advantages, the breeder is encountering opposition. Opponents argue that many safety questions have not been answered, and as plutonium is an ingredient of atomic weapons, there is the danger of thefts and sabotage. Although the U.S. Energy Research and Development Administration wants early commercialization, the Environmental Protection Agency is pushing for delays.

Says Sharrah: "A U.S. breeder reactor will need years of demonstration to establish its reliability, and many safety and environmental issues will have to be resolved before commercialization can be considered. Because of these factors, the breeder will not be ready before the mid-1990's at the earliest."

### Geothermal Energy

In some areas of the world, like the Imperial Valley of California, energy comes to the surface as a hot saline water or steam-brine mix. Harnessing power from these reservoirs will be complicated as the brines are highly corrosive to pipelines and turbines.

Theoretically, hot dry rock could be reached from anywhere on the earth's surface by drilling, and could provide inexhaustible sources of energy. Most of the outer crust of the earth is relatively cool down to about 20 miles. To get to the reservoirs, holes would have to be drilled into the earth, and a fluid would have to be put down some of the holes to be vaporized. Although technically feasible, such projects would be tremendously expensive, according to Sharrah. "I rank getting energy from hot dry rocks lowest in probability for early commercial development," he says.

### Solar Energy

Solar energy is already heating and cooling buildings, but a solar heating system currently adds about $5000 to the cost of a $40,000 house in Tucson, Arizona, which has one of the best climates in the United States for utilizing the sun's power.

Technical and cost improvements in solar heating and cooling are likely to be small, Sharrah believes. On the other hand, he says that converting sunlight directly to electricity, through the so-called photovoltaic effect, does have considerable margin for improvement.

Photovoltaic conversion uses solar cells to convert sunlight directly into electricity, a process that is already providing electric power for satellites in space. The thermal efficiency of photovoltaic devices is still very low—11 percent—and the cost very high—about $30 a watt. A single power plant might cost $30 billion using present solar cells. But improving thermal efficiency or reducing the cost of the solar cell could considerably lower power plant costs.

Sharrah comments: "Solar cells require no fuel other than sunlight, are relatively indestructible, and require little, if any, maintenance. When an economical way to convert sunlight to electricity is found, the photovoltaic alternative could be a major source of power. I don't believe, however, that it is just around the corner."

### Nuclear Fusion

Sharrah says, "Man has never tackled a tougher engineering problem than the development of a fusion reactor. Although scientists have been trying for 20 years, using powerful magnets, lasers, electron beams, and other exotic tools, no one has yet made controlled nuclear fusion produce more energy than it consumes. There are nearly 200 controlled-fusion experiments in 14 countries. Researchers in the Soviet Union, Western Europe, Japan, and the United States have moved steadily closer to the goal of energy break-even, and we can look for some significant advance in the next 10 years. But even then fusion can hardly be expected to make a contribution to our energy supplies until well into the next century."

From tar sands to nuclear fusion, there is a wide variety of alternative fuels on the horizon. In Sharrah's opinion, synthetic fuels have a significant role to play in America's energy future—but it will be many years before that role becomes a starring one.

# Rejuvenate Old Steam Stations, Urges United Technologies

STATE LINE, NEVADA—Roughly 20 percent of fossil-fired generating capacity installed before 1960 is an "excellent candidate" for gas turbine repowering, according to an analysis presented by United Technologies at the Intersociety Energy Conversion conference here.

Repowering, as defined in the study, means replacing the boiler in an existing steam station with a new gas-turbine/waste-heat-boiler package linked to the existing steam turbine. The resulting combined-cycle generating plant will have two to three times the capacity and a lower heat rate than the original steam plant, at relatively low cost.

The analysis of repowering candidates was performed at United Technologies research center to determine the market potential for an "advanced state-of-the-art" gas turbine such as the FT50. This is a 100-MW class gas turbine being developed by Turbo Power & Marine Systems, a United Technologies subsidiary.

The analysis is based on the Federal Power Commission's "Form 12" data for 29 utilities, representing large, urban companies likely to have old, small steam stations still in service. The analysts found that these utilities have 697 fossil-fired units, accounting for 50,307 MW, that were installed before 1960 and are still running. The coal-fired units were eliminated as repowering candidates because the heat rate improvement might not overcome the fuel cost disadvantage of repowering. That left 403 units, representing 26,775 MW, as candidates. Of these, the tiny ones—those too small to accommodate a 100-MW gas turbine—were eliminated, leaving 312 units, representing 25,215 MW.

Next, steam conditions were considered. Because the gas turbine exhaust was assumed to be at 900-950F, steam turbines designed for inlet steam hotter than 800F were eliminated as candidates for unfired repowering. (The waste heat boiler can be fired with supplemental fuel or unfired.) It was found that 105 units might be suitable for unfired repowering, 207 for fired repowering.

The final factor was net cost of repowering vs. heat rate of the steam station to see if the reduced heat rate could offset the conversion cost. The economic analysis used cost and heat rate predictions for a system based on the FT50 gas turbine—in which the heat rate of the repowered station was assumed to be 7420 Btu/kWh, while conversion cost for adding two gas turbines and a waste heat boiler was set at $140 to $160 per kW of repowered station capacity.

The analysis showed that the cut-off point for the "unfired" candidates was 10,000 Btu/kWh. An existing steam station with a heat rate below 10,000 Btu/kWh (and steam conditions below 800F) would not be economic. The cut-off point for "fired" candidates was 11,000 Btu/kWh. That left 73 candidates for unfired repowering and 102 for the fired option. The total, 175 units, accounts for 11,495 MW, or about 20 percent of the original candidate list.

The United Technologies research team says that the 29 utilities analyzed have 45 percent of the total pre-1960 capacity in service. Extrapolating their findings to the entire utility industry, they calculate that there are 25,500 MW of repowering candidate capacity.

The analysts calculated an example of potential savings: A station heat rate that is dropped from 12,500 Btu/kWh to 7420 Btu/kWh allows the owner to burn higher cost fuel ($2.25/million Btu fuel vs. $2.00/million Btu) with a fuel cost contribution (to electric power cost) still reduced by approximately 8.3 mills/kWh.

Repowering also could be used to reduce oil consumption. Of the 25,500 MW of candidate capacity, 8,500 could be used with 17,000 MW of new gas turbine capacity in repowering projects and the remaining 17,000 of old steam capacity could be put on cold reserve status. The resulting generating capacity would be the same, but oil consumption would drop by 15 percent, or 75 million barrels a year.

# Fuel Storage Rack Licensed By NRC

CAMPBELL, CA—High density fuel storage racks designed by Nuclear Services Corp. for the Zion Nuclear Station have been licensed by the Nuclear Regulatory Commission.

The racks, made by Speedway Machine and Tool of Indianapolis, will increase Zion's spent fuel storage capacity by 160 percent. They are of an all stainless steel, flux trap design, with no special poisons. The center-to-center spacing for fuel element storage is 14 inches. Twenty of these racks will be installed at Zion.

Nuclear Services Corp. will contract for supply of the rack equipment.

(*Nuclear Services Corp.*, 1700 Dell Ave., Campbell, CA 95008. Phone: 408-446-2500.)

# *Refuse Put to Good Use in U.K.*

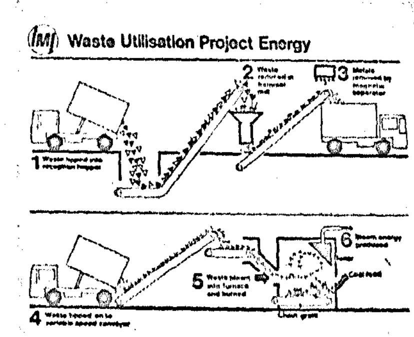
BIRMINGHAM, England—Shredded refused provides 50 percent of the thermal output of a system in use here for firing power generation boilers. U.S. fuel costs are estimated to be only $0.15 per therm, and the combustion techniques are said to be so highly developed that boiler fouling and corrosion are eliminated.

The system design is available from Imperial Metal Industries, a metal and plastics products manufacturer currently using the system at its 50,000 kW central power house.

At a pulverizing station, refuse is unloaded into a hopper fitted with a conveyor. This feeds the rubbish into a hammer mill that breaks up the refuse so that 90 percent is less than three inches across.

From the mill, refuse is discharged onto a conveyor belt and passed through a magnetic separator that extracts about 80 percent of the iron and steel. The shredded refuse is then discarded into containers and trucked to the power station. There it is discharged onto a conveyor belt and fed at a controlled rate to burners fitted into the rear walls of the chain grate boilers.

(*Imperial Metal Industries, Ltd.*, P.O. Box 216, Birmingham B6 7BA, England.)




Steps involved in reducing refuse to a usable fuel at a plant in England.