Energy Studies

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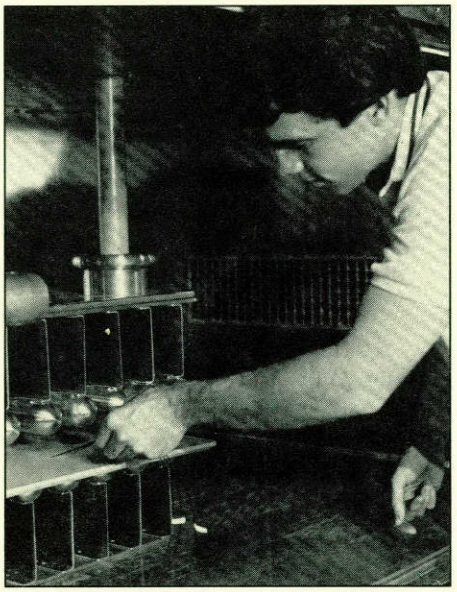
The Center for Energy Studies is a multidisciplinary research center, the central liaison for energy research, education, and public service at The University of Texas at Austin. Dr. Herbert H. Woodson is director.

Editor: Jennifer Evans

EPRI Awards $500,000 for Investigation of Microwave, RF Heating

The Electric Power Research Institute (EPRI) has awarded $506,000 to the Process Energetics Program for research on dielectric heating and drying of industrial materials.

Dielectric materials do not conduct electricity. According to Vince Torres, manager of the Process Energetics Program, microwave and radio-frequency (RF) waves are effective methods of heating dielectric materials.



Tim Bielek, electrical and computer engineering graduate student, inserts probes to measure the temperature of sample material inside an 8-kilowatt radio-frequency test system. The center's Process Energetics Program is studying innovative ways of heating and drying industrial products.

Improvements such as faster processing, energy savings, and higher product quality can often be achieved with dielectric heating and drying.

The researchers will test and model water-absorbing and non-water-absorbing target materials and verify models with further tests on actual industrial materials. They also will study how to improve dielectric applicators, the elements that distribute the electromagnetic energy that heats the material.

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Center Wins $956,000 for Four Projects from State Program

The Texas Higher Education Coordinating Board April 21 awarded $956,000 to the Center for Energy Studies for four research projects on rotating machines and transformers, industrial drying, water clean-up, and combustion.

Funding for the projects came from a $60 million appropriation by the Texas Legislature to enhance the state's economic growth by increasing and improving research at the state's universities. The appropriation supports two funds, the Texas Advanced Research Program and the Texas Advanced Technology Program.

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Mr. Torres said the data analysis and processing programs will continue to be developed so that immediately after a material is tested, data may be transferred to a computer model. Researchers can learn, for example, "What would be the processing time, energy use, and equipment size for drying 100 pounds of this material an hour?"

The researchers will also perform approximately six preliminary feasibility studies and one comprehensive one. One or more of the case studies may lead to a pilot project involving UT, EPRI, an existing plant operation, and the local electric utility that serves it.

Principal investigators leading the EPRI project are Philip S. Schmidt, Melba M. Crawford, and Theodore L. Bergman, all UT mechanical engineering faculty members, and John A. Pearce, associate professor of electrical and computer engineering.■

CES Update

Conservation and Solar Energy

The Conservation and Solar Energy Program has received **funding for four new projects:**

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has given the program $53,000 to measure and evaluate the performance of an indirect evaporative cooler.

The Texas Governor's Energy Management Center has funded a $42,000 expansion of a project to revise and update the state's energy conservation standards for buildings.

Approximately $19,000 was awarded by the Resource Management Department of the City of Austin for analyzing energy use in municipal buildings.

The city's Electric Utility has given $25,000 for a project to assess the potential for concentrating solar collectors in the Austin, Texas, area.

■

Conservation and solar researcher **Gary C. Vliet** has gone on sabbatical to Queen Mary's College of the University of London.

There Dr. Vliet, a professor of mechanical engineering, is studying application of the second law of thermodynamics to industrial processes and falling-film absorption. He will return in late June.

Geopressured-Geothermal Energy

A geopressured-geothermal design well sponsored by the US Department of Energy (DOE) in Louisiana "has far exceeded predicted reservoir performance," according to geothermal expert Myron H. Dorfman.

Dr. Dorfman heads the center's Geopressured-Geothermal Energy Program and holds the W.A. "Tex" Moncrief, Jr., Centennial Chair in Petroleum Engineering at the university.

Deep, high-pressure geopressured-geothermal formations that contain hot salty water and natural gas are found along the Texas and Louisiana Gulf Coast. Research is directed toward economic production of the natural gas and power generation by means of the pressure, heat, and/or gas.

Three years of testing were finished in February on the Louisiana well, Gladys McCall No. 1. During the three years it sustained flow rates of more than 31,000 barrels a day and produced 27 million barrels of water and 1 billion cubic feet of natural gas, about 30 standard cubic feet per barrel, Dr. Dorfman said.

The gas was sold commercially, and the water was reinjected into shallower strata without difficulty.

Why the well outperformed predictions is not yet clear, said Dr. Dorfman, but the reason may be recharge from shale formations.

The Electric Power Research Institute is building an electric power facility at a Texas geopressured-geothermal well 45 miles south of Houston. This well, Pleasant Bayou No. 2, drilled in 1979, was the first geopressured-geothermal well in the country.

Scheduled to be operating in fall 1988, the power facility will convert heat, pressure, and natural gas from the Pleasant Bayou well into electricity.

The Department of Energy and industry have sponsored geopressured-geothermal research by the center and the UT Bureau of Economic Geology since 1974.

Currently the UT researchers provide engineering and geological expertise on the project, monitor well production, carry out reservoir engineering and well log research, and maintain a data base, the Geopressured-Geothermal Information System.

■

The Geological Society of the Royal Academy of London has invited **Myron Dorfman** to present a paper June 1 on "New Techniques in Lithofacies Determination and Permeability Prediction in Carbonates Using Well Logs." The topic is an outgrowth of the geopressured-geothermal research.

Nuclear Studies

Dale E. Klein, deputy director of the center, has been appointed to a national panel of experts who will study the **storage of high-level nuclear waste.**

Speaker Jim Wright of the US

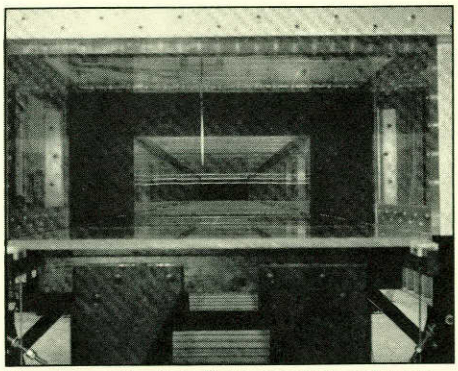
(Continued on next page)

House of Representatives March 18 announced Dr. Klein's appointment to the Monitored Retrievable Storage System Commission. The panel will evaluate a monitored retrievable storage (MRS) facility as part of the nation's nuclear waste management system and prepare a report to Congress by June 1989.

The MRS Commission was established by the Nuclear Waste Policy Amendments Act of 1987, which also paved the way for a major repository of high-level nuclear waste to be built in Nevada.

According to Dr. Klein, the purpose of an MRS facility is to prepare and repackage high-level nuclear waste, principally spent fuel from power plants, before it is stored at the long-term disposal site.

Dr. Klein, an associate professor of mechanical engineering, has directed the Nuclear Engineering Teaching Laboratory since 1978. He holds a PhD in nuclear engineering from the University of Missouri-Columbia and has served on several committees dealing with nuclear waste. He is conducting research on nuclear shipping containers.



Roughened rather than smooth surfaces transfer heat well because of their larger contact area and their ability to stir and mix the air flowing by. An 80-foot wind tunnel recently installed in the center's experimental bay is being used in a study of solid-to-gas heat transfer from roughened surfaces. The research has application to chemical processes, electronic circuitry, nuclear power, and heat exchanger design. Participants in the project, funded by the National Science Foundation, are Dale E. Klein, deputy director of the center; J. Parker Lamb, aerospace engineering professor; and engineering students Michael Krause, Michael Michael, and Jon Young.

Process Energetics

A symposium on microwave and radio-frequency heating will be held in Austin June 28-29 and will include an open house at the center's Process Energetics laboratory.

The conference is aimed at utility personnel involved with industrial customers seeking to improve their energy efficiency, productivity, and product quality through the use of electrotechnologies, according to the symposium's coordinator, Milton A. Williams, of Energy Management Consultants.

The symposium is sponsored by the Electric Power Research Institute and will be held at the Airport Marriott Hotel in Austin.

Faculty and staff researchers of the Process Energetics Program will conduct tours of the group's research facilities at the Balcones Research Center, perform dielectric heating demonstrations with experimental equipment, and discuss current research results.

Attendance is limited to utility personnel and costs $375 (free to EPRI members). The agenda includes innovative applications of industrial microwave and radio-frequency heating, the technical and economic aspects of these electrotechnologies, and case studies of utility development and promotional programs aimed at industrial customers.

For information about the symposium, contact Milton A. Williams, Energy Management Consultants, Box 26530, Austin, Texas 78755, 512/345-8052.

■

Philip S. Schmidt, head of the Process Energetics Program, gave the plenary address of the Second Canadian National Congress on Electrotechnology April 11 in Toronto.

John A. Pearce, associate professor of electrical and computer engineering, and **Mike Sanio**, graduate student in mechanical engineering, made invited presentations on dielectric heating for materials processing at the Symposium on Microwave Processing of Materials April 5-9 in Reno, Nevada.

Dr. Pearce was presented the Faculty Leadership Award by the UT Department of Electrical and Computer Engineering.

Separations Research Program

Separations researchers have completed testing of seven types of **high-efficiency packings used in distillation.**

From the experimentation, led by James R. Fair, head of the Separations Research Program, and Jose Luis Bravo, the program's manager, the group has developed predictive computer models and a manual for use in designing distillation systems with high-efficiency packings.

Mr. Bravo said that high-efficiency packings have been popular since the late 1970s. These kinds of packings (see photograph) are usually made of perforated, corrugated metal or plastic and can increase product output (by as much as 50 percent), reduce energy consumption, or improve the product's purity.

Distillation is the most common technology for separating liquids. It is used to make petroleum products, foods, flavors, drugs, and chemicals, and even to separate air into nitrogen and oxygen.

In the simplest form of distillation, a liquid mixture--for instance,

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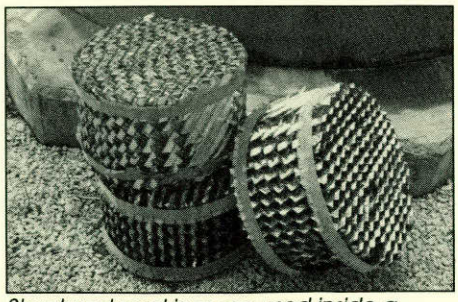

Structured packings are used inside a distillation column to improve the efficiency of the process.

alcohol and water--is heated, and a vapor boils off. The vapor contains more alcohol than water, because alcohol is more volatile than water. The vapor can be condensed and the process repeated until the desired concentration of alcohol is achieved.

In modern-day distillation, the process is more efficient because vapor is repeatedly pumped back through liquid. The heat of the vapor is thus recaptured and reused, and the injected vapor causes a more concentrated vapor to be given off.

The most efficient distillation columns contain packings to maximize the vapor-liquid contact area. Some packings, however, create too much friction and resistance and require excessive energy for pumping. This friction is called *form drag*.

High-efficiency packings minimize form drag while maximizing vapor and liquid contact, said Mr. Bravo. The experimentation and modeling show that different packings perform best in different applications, and no one packing type outperforms the rest.

Other researchers on the project are Christian Fischer, Chris Martin, Bobby Reeves, and chemical engineering graduate students Jeff Hufton and Gerald McGlamery.

■

Eastman-Kodak, the Institut Français de Pétrole, and Kerr-McGee Corp. have joined the Separations Research Program as sponsors, bringing the total number of sponsors to 29, James R. Fair, head of the program, announced.

The sponsor meeting held April 6, attended by 102, was the largest in the program's four years of existence.

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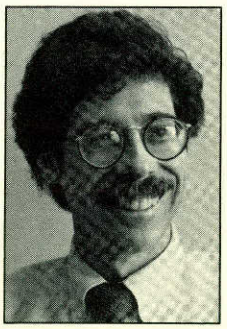
Separations researcher **William J. Koros** has been named one of four Outstanding Young Texas Exes by the Ex-Students' Association of The University of Texas at Austin.



William J. Koros

Dr. Koros earned three degrees in chemical engineering from UT, including a PhD, received in 1977. At present he is the Paul D. and Betty Robertson Meek and American Petrofina Foundation Centennial Professor in Chemical Engineering at UT.

His research in separations with polymer membranes is sponsored by the center's Separations Research Program, NASA, the US Navy, and the National Science Foundation. Dr. Koros also is a Presidential Young Investigator.

■

Chemical engineering PhD candidate **Scott Barnicki** in April won a Fannie and John Hertz Foundation Research Fellowship. ■

UT Austin Energy

DOE Funds National Oil Recovery Institute at UT Geology Bureau

To increase research on oil and gas recovery, the US Department of Energy (DOE) has awarded $500,000 to form a national consortium to be administered by the UT Bureau of Economic Geology.

Initial plans for the new Geosciences Institute for Oil and Gas Recovery Research were approved in February at a meeting among Allen Wampler, DOE assistant secretary for fossil fuels, Texas Governor Bill Clements, and Bureau Director William L. Fisher..

Because of the oil price collapse and the decline of the domestic petroleum industry, the federal government sees a need to fund research in oil and gas recovery, according to DOE spokesman Bob Porter. DOE has requested $17 million for oil and gas recovery research, the largest budget request on the topic since 1982.

Marcus Milling, director of the geosciences institute, said DOE is expected to increase funding incrementally for the institute. To receive funding, the members must match DOE grants one to one with nonfederal dollars.

UT and fourteen other university and state organizations in oil-producing regions will participate in the consortium. Universities that are not members of the institute may propose projects for funding as well.

The UT Austin representative on the institute's advisory board is Robert Finley, research scientist at the bureau, and the alternate is Gary A. Pope, professor of petroleum engineering.

Dr. Milling said that in the next four to five months the institute will develop a long-range plan, set research priorities, and present them to DOE for review. The research emphasis will be on reservoir characterization and oil and gas recovery.

The concept of "mobile unswept oil" is gaining recognition among geoscientists, according to Mr. Porter. About two-thirds of the oil in a reservoir cannot be recovered with standard techniques. The oil was commonly thought to be too viscous to be mobile.

An alternative theory, under study at the Bureau of Economic Geology, holds that a great deal of the oil is in fact mobile and can be removed if wells are geologically targeted to the reserves.

Part of the impetus for the institute came from recommendations of the Energy Research Advisory Board of the Department

of Energy. In a February 1987 report, the board recommended that DOE refocus geoscience research funding with oil and gas as the top priorities.

The report stated, "Oil and gas are given top priority because of their overall dominant role in energy usage and because the major energy problem facing the nation in the intermediate future is a shortage of domestic liquid hydrocarbon fuels, which threatens the nation's energy security and international competitiveness."

Clements, Bentsen Host National Energy Summit September 6 at UT

Texas Governor Bill Clements and Senator Lloyd Bentsen will host a national energy summit September 6 at The University of Texas at Austin.

The gathering is expected to attract energy experts and political figures from across the nation. Its purpose is to develop a national energy plan for the use of the next president.

Attendance will be by invitation only, and oil and gas issues will be a major topic, said Auburn Mitchell, energy advisor to Governor Clements.

The national energy summit will be held at the LBJ School of Public Affairs and at the Joe C. Thompson Conference Center. ■

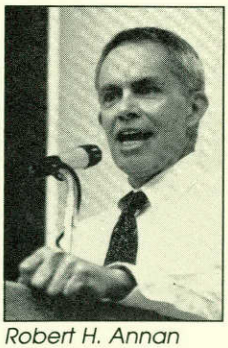
Emerging Energy Technologies

It's a tough market, affected by trade barriers, utility regs, and the Arab yo-yo.

Marketing emerging energy technologies may be difficult in the United States because of low oil prices, and difficult in foreign countries as well because of trade barriers.

This view was a predominant message of a conference on **Emerging Energy Technologies in Texas** held March 10-12 at UT Austin.

Bright spots in the picture for emerging energy technologies also were noted: increasing cogeneration in Texas, improvements in photovoltaic technologies, and Austin and San Antonio's energy incentive programs.



(Photos by L. M. Holder III)

Robert H. Annan

Selling energy abroad. Robert H. Annan, director of the Photovoltaic Energy Technology Division of the US Department of Energy (DOE), told the audience of 220 that the US renewable energy industry is "just a shell of what it was before," but "the Third World wants technology and wants expertise. The Americans have that."

He said the need for renewable energy in the rest of the world is "phenomenal" and predicted that US firms will sell more wind machines in India in the future.

The Caribbean is an excellent market for emerging energy technologies that is close at hand, Dr. Annan pointed out.

William A. Donaho of the US Department of Commerce said marketing solar, wind, and other technologies abroad is not easy, but can be profitable and rewarding. He cited barriers of language, cultural differences, distance, trade tariffs, and competition from other nations.

The US Export Council for Renewable Energy is one of the most active export councils in the country, Mr. Donaho said.

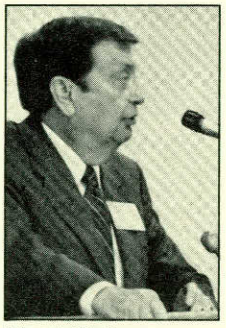
"Many countries look to the United States as a leader in renewable resource technologies."

Vaughn Nelson, director of the Alternative Energy Institute at West Texas State University, said that a principal reason projects fail in foreign countries is lack of maintenance expertise. For instance, in 1972 the US government installed 200 farm windmills in Costa Rica. Today one is still running. "They put it up, they go, and the project fails," he said.

Low-tech methods of water pumping are another major market in the Third World, according to Dr. Vaughn.

Arab yo-yo. The reason emerging energy technologies are hard to sell today is that oil prices are low.

"We're on the Arab yo-yo," said Mack Wallace, former chairman of the Railroad Commission of Texas.



Mack Wallace

"You're watching one of the great living tragedies this country is facing, a strategic industry dismantled before your eyes. . . . The roughnecks have gone to the carwashes and filling stations. . . . Domestic producers are crying for relief. *They* are our Strategic Petroleum Reserve."

"The man on the street thinks everything is rosy," said Edward O. Vetter, chairman of the Texas Department of Commerce. "The energy situation is even more precarious in 1988 than in 1978," because the nation is more dependent now on foreign oil, and price volatility prevents domestic producers from making long-range plans.

A floor on the price of oil of

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$18 per barrel would help the oil industry but would not stimulate emerging energy technologies, Mr. Vetter said.

He recommended that the emerging energy industry seek out its own competitive market niches and boutique applications rather than attempt to compete with central-station generation of electricity or rely on tax breaks that could end abruptly.

Mr. Vetter pointed out that the country's energy conservation has increased substantially: at present 307 million Btu of energy are consumed per capita versus 351 million Btu in 1978, a drop of 12.5 percent.

Edward O. Vetter

State of Texas slow. Carol Tombari and Timothy J. Grigg of the Governor's Energy Management Center said state buildings represent a large opportunity for energy conservation. Two audits were conducted in 1987 of nearly one-third of buildings owned by the state.

The results showed that if energy efficiency measures costing $42 million were installed, the changes would save the state $21 million a year. Mr. Grigg said the most effective retrofits for the state would be lighting changes; use of variable-speed drives on pumps and fans; retrofits of heating, ventilating, and air-conditioning systems; and use of automatic energy management controls.

The state's budget problems are the principal reason little progress has been made toward energy retrofits of state buildings, said Ms. Tombari.

The Austin State Hospital and Texas Tech University are considering a move to cogeneration, said Mr. Grigg, and Southwest Texas State University is now building such a system. He predicted that more good candidates for cogeneration among state buildings will emerge.

Big brother cogeneration. "The jury is still out" on whether cogeneration is "the big brother forcing the door open for renewable resources, or the big brother that will trample on renewable resources," said the chairman of the Texas Public Utility Commission, Dennis Thomas.

Carol Tombari

The growth of cogeneration has long since surpassed predictions, said Dr. Thomas, and has fundamentally changed the state's electric power industry—to the benefit of consumers. He now predicts that cogeneration will top out at 10 to 12 percent of the state's electricity supply.

Within the Public Utility Commission two debates are likely to be raised soon, he said. The first deals with whether a higher price must be paid for power from renewable sources when utilities are required to buy from small power producers.

The second involves the fact that recently utilities have begun to market power more actively. How far should the PUC allow utilities to go in pushing electricity?

Dr. Thomas said he supports some marketing, but "to convince a customer to make a noneconomic decision is breaking faith with the customer."

William E. Avera, a member of the Energy Task Force of the Austin-San Antonio Corridor Council, said that local utilities should lead the way in bootstrapping the emerging energy industry, which would benefit the economy of the region.

The PUC should "create a cooperative environment, especially for utilities to take some chances, within bounds and within reason," he said.

San Antonio follows Austin. "You can't sell a mousetrap to people who think they don't have mice," the director of the Austin Resource Management Department, June Appel, told the audience.

In an Austin survey, more than two-thirds of the respondents believed their homes were already energy efficient, she said, and another fraction thought their homes were beyond help.

Ms. Appel said that what consumers want is comfort, convenience, and an improved financial picture. Buyers of energy products are more interested in its benefits than its features.

San Antonio Mayor Henry Cisneros acclaimed the city of Austin as "a pioneer for years in conservation. . . . San Antonio recast our whole energy plan to track Austin's," principally to introduce incentives for customers to install energy conservation measures.

June Appel

Mayor Cisneros said he hopes the Austin-San Antonio corridor will "gain a reputation as one of the few places in the country looking into the technologies discussed here."

"Texas needs more options than oil and gas" said Austin Mayor Frank Cooksey. "We've tried to make Austin a center of thought about new ways of exploring technology."

Cosponsors of the conference were

UT Center for Energy Studies; Electric Utility Department, City of Austin; Governor's Energy Management Center; Greater Austin-San Antonio Corridor Council; Lower Colorado River Authority; Resource Management Department, City of Austin; Texas Department of Commerce; Texas Renewable Energy Industries Association; Texas Solar Energy Society; and US Export Council for Renewable Energy. ■

Fickle Natural Gas

Should we meet climbing demand for electricity with cogeneration?

(Deputy Director of the center Dale E. Klein presented testimony February 19 before the Texas House Select Committee on a Statewide Energy Plan, chaired by Rep. Terral Smith. Below are excerpts from his testimony.

The charge to the committee is to "study the various means by which the Legislature can impact the economic revitalization of Texas through the development of a statewide energy plan." Meetings will be held May 27 in El Paso, June 17 in Lubbock, and July 15 and August 12 in Austin.)

I want to address the broader issue of energy policy, of which cogeneration is an integral part. The views expressed are my own and do not reflect those of The University of Texas.

My primary concern, as I am sure has been expressed by others, is not with cogeneration as a potential energy resource. There is a large potential due to the presence of many companies that use process steam.

However, premature legislative action might be recommended based on the false assumption that cogeneration, especially when natural gas is used as a boiler fuel, is a viable long-term energy resource in this state.

I do not believe electricity generated by natural gas gives the electric consumers of this state the kind of price and supply security that is needed for successful economic growth and development.

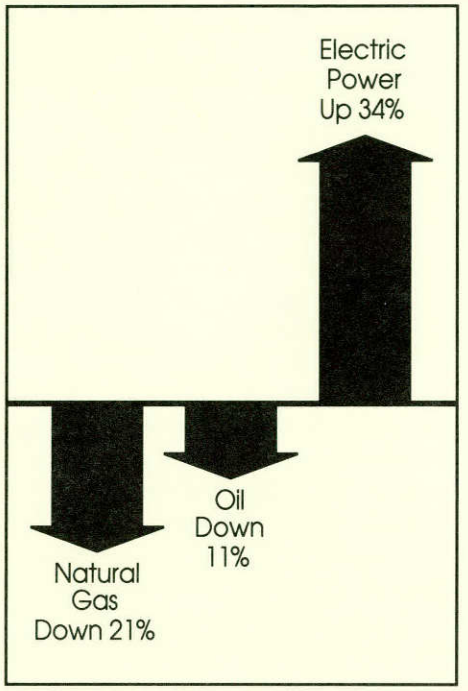
OPEC strong in mid-1990s? While natural gas no doubt will always play a key energy role in Texas, only coal and nuclear energy can supply our consumers with adequate amounts of electricity at reasonable prices, now and in the future. Natural gas should be used for peak loads, while coal and nuclear should be used for base loads. We are currently in an unusual pricing situation where some utilities are using natural gas rather than coal for base loads.

Recent American Petroleum Institute figures show that oil imports have risen 67 percent since 1985. Meanwhile, Americans are using more petroleum products, even as production is down. Further, API notes, OPEC's monopoly power over oil prices and supply can be restored if the demand for its oil reaches 80 percent of its total production capacity of 27 million barrels. At the current world price of about $15, and if current trends continue, we could see a restoration of OPEC control in the early to mid-1990s.

Whether or not OPEC could exercise its monopoly pricing and supply power once regained, we do not know. But it was precisely because of the volatility of oil and natural gas supplies and prices that utilities in Texas and across this country began diversifying their fuel base with coal and nuclear power.

Oil as a weapon. I might add, it was also because of the fear of energy shortages and continued escalating prices that Congress passed the Public Utilities Regulatory Policy Act, or PURPA, in 1978, which is responsible for the spate of cogeneration in the recent past. One of the primary goals of this law was to save oil and natural gas. Congress also passed the Fuel Use Act, prohibiting the use of natural gas in new boilers, and originally phasing out existing gas-fired boilers.

There cannot be any doubt of the wisdom of these and other policies, such as conservation and efficiency programs. They were meant to boost this country's energy self-sufficiency and serve as a hedge against the OPEC cartel using oil as a political and diplomatic weapon against the free industrial nations of the world.



Energy Consumption in the United States since 1973 (Source: US Council on Energy Awareness)

Today, Americans are using 21 percent less natural gas and 11 percent less oil than in 1973. Total energy use today is actually slightly less. This is a testimonial to the ability of Americans to squeeze more production out of fewer and fewer Btus.

High tech means electric tech. There is a glaring exception to this trend, however. Since 1973 the United States has continued to use more electric power--36 percent more, in fact. Today, we are using 65 percent more coal to make electric power. Nuclear energy is up 360 percent. The close rela-

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The Coordinating Board received 3,223 proposals and funded 339. About 30 percent, 101 grants totaling $17.7 million, went to UT Austin researchers.

At the Center for Energy Studies, the four, two-year projects that were funded are

- *The use of third-harmonic flux to reduce losses and improve performance in rotating machines and transformers,* Herbert H. Woodson, $398,000
- *Research in enhanced drying technology,* Philip S. Schmidt and John A. Pearce, $231,000
- *Investigation of separations methods for clean-up of aqueous wastes and contaminated source waters,* James R. Fair, $213,000
- *Combustion in porous inert media,* Ronald D. Matthews and Steven P. Nichols, $114,000

Among other energy-related projects at UT Austin that won funding were

- *Demonstration of a low-cost high-field toroidal magnet system for fusion,* William F. Weldon, $900,000
- *Nuclear technology study of the fusion ignition experiment IGNITEX,* Nolan E. Hertel and Gary A. Hallock, $344,000
- *New materials for energy conversion and storage,* John B. Goodenough, $220,000
- *Accurate modeling of fluid flow in hydrocarbon reservoirs and aquifers with scale-averaged rock properties,* Larry W. Lake, $198,000■

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tionship of electric demand and the growth of the Gross National Product signals the linkage between these two. Earlier this year, a National Academy of Sciences report said electric demand and economic expansion will grow in tandem throughout the rest of this century.

Electric processes such as induction heating, laser processing, and robotics are helping to boost productivity. Industrial heating and curing with microwaves are saving dollars and energy. Expanded computer operations are evident in all sectors of the economy. The very mention of the words *high technology* connotes an increasing use of electric power.

Unfortunately, nothing has fundamentally changed since the 1970s despite the current world oil glut and lower prices. The threat of OPEC's monopoly power has taken a hiatus. The long-range potential for its control is obvious when we consider that more than half the world's oil reserves are in the Persian Gulf. The United States has only 5 percent of the world's petroleum reserves.

Gas and cogeneration not for base load. Cogeneration has a particularly important role to play on the Gulf Coast of Texas, because of the large amount of petrochemical production. I believe it would be a serious mistake to promote cogenerated electricity as a *primary energy resource,* despite the short-term appeal, only to see those gains wiped out by rapid changes in the supply and price of natural gas.

The question before our state's leaders is not whether we are for cogeneration and against coal and nuclear power. It is not whether we are pro-conservation and anti-large central station power. Or whether we must choose between utilities and chemical companies. Such arguments undermine the importance of long-range energy planning for a state that has to reorder its industrial priorities over the next 15 years.

Surely cogeneration has an important role to play. But coal and nuclear power for base load generation along with conservation are likely to remain our three most reliable energy options over the long term. I hope the committee's recommendations will support such an end.■