

Railplug project receives \$2 million from DOE and private sources—page 3

Energy Studies

Volume 16 Number 4
March/April 1991

Newsletter of the Center for Energy Studies of The University of Texas at Austin

Energy Studies reports on activities of the Center for Energy Studies and other energy-related news from The University of Texas at Austin. Subscription is free upon request (six issues a year). ISSN: 0743-829X.

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. John R. Howell is director.

Editor: Jennifer Evans



Researchers help trim energy bill of underground 4-acre Capitol Extension

The Texas Capitol will have a new four-story neighbor by 1992, but this new state building won't block Austinites' view of the Capitol. The view may even improve.

The building, called the Capitol Extension, will be built completely underground. Two center researchers recently conducted a study of the structure, now under construction. They found that the final design is energy efficient and "comfortably passes" the state's new energy standard.

According to the State Preservation Board, which oversees the project, the purpose of the Capitol Extension is to relieve the crowding in present Capitol offices, improve safety, and provide 680 parking spaces. The lower two of the four

levels will be parking, and tunnel walkways will connect to the basements of the Capitol and surrounding buildings.

The project has required excavation of a hole 60 feet deep through solid limestone. About 680,000 tons of rock—equivalent in weight to four and a half Washington National Cathedrals—have been hauled away by truck. The structure will be the largest underground building in Austin.

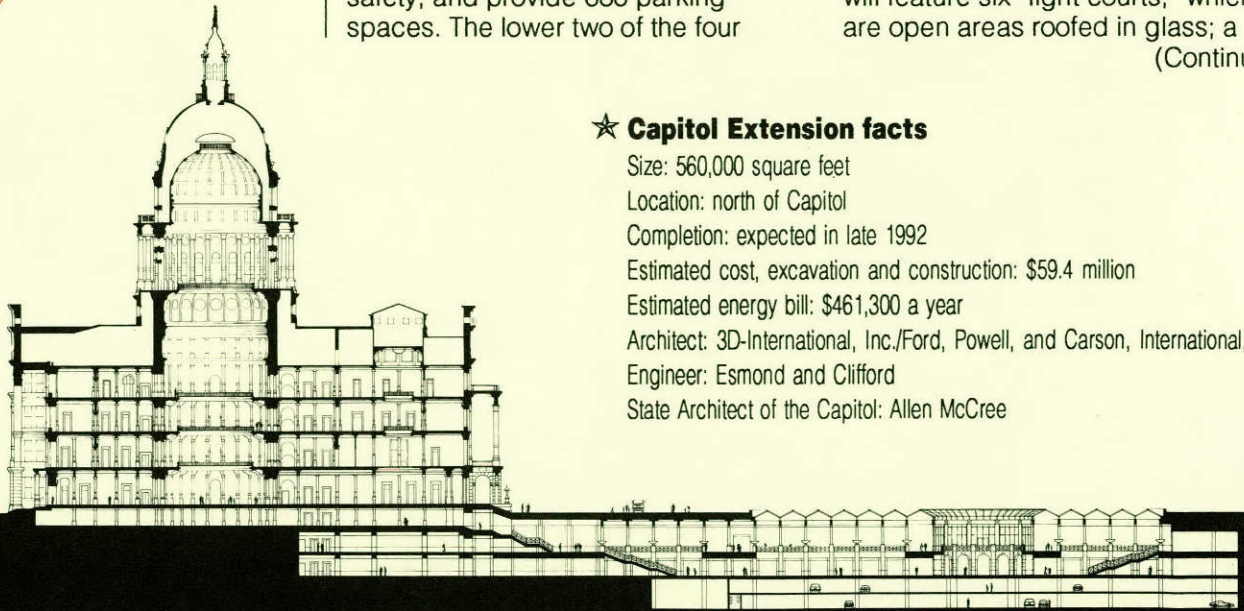
Governor Ann Richards and other top state officials plan to move their offices temporarily into part of the extension while a renovation of the Capitol itself is under way.

The underground office building will feature six "light courts," which are open areas roofed in glass; a

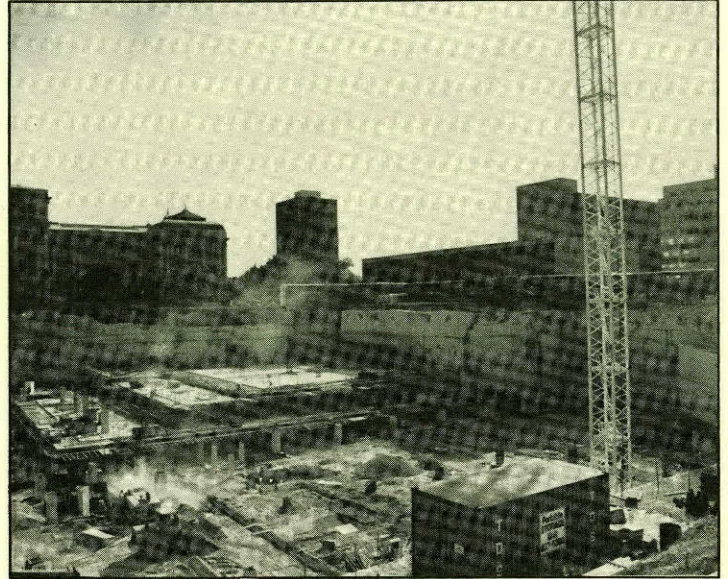
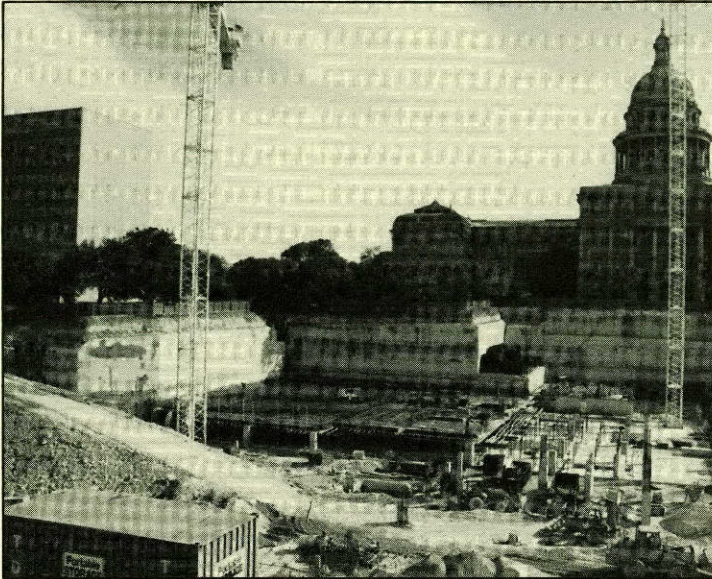
(Continued)

★ Capitol Extension facts

- Size: 560,000 square feet
- Location: north of Capitol
- Completion: expected in late 1992
- Estimated cost, excavation and construction: \$59.4 million
- Estimated energy bill: \$461,300 a year
- Architect: 3D-International, Inc./Ford, Powell, and Carson, International, Inc.
- Engineer: Esmond and Clifford
- State Architect of the Capitol: Allen McCree



Drawing courtesy of State Preservation Board



A total of 680,000 tons of rock and soil, 400 truckloads a day average, were removed from the site of the Capitol Extension.

skylit central gallery; and an underground, granite-faced rotunda open to the sky. Offices, sixteen committee rooms, auditorium, cafeteria, press area, bookstore, and underground loading dock will be part of the new building. Large trees temporarily removed from the site will be re-planted on the "roof."

Bruce D. Hunn and James Hitzfelder carried out a detailed computer evaluation of the building's energy performance for the Governor's Energy Office. Dr. Hunn is head of the center's Building Energy Systems Program, and Mr. Hitzfelder, a former researcher with the program, is now with the Physical

Plant of the UT Balcones Research Center. Large underground buildings are unusual, and this one is complex to model, Dr. Hunn said. Applying the methods of the Texas energy standard and a computer program called DOE-2, the researchers compared the energy required by the underground design to that required by a closely comparable office building built above ground and having standard windows.

When the two buildings' predicted energy behavior was modeled on an hourly basis for a year, down to the exhaust fans in the kitchen and the average number of occupants each hour of the day and night, the researchers compared the results. The simulations show the building as designed will use \$461,300 of energy a year, while the above-ground prototype building would use more, \$547,800.

The underground design is thus 16 percent more energy-efficient than the above-ground prototype and passes the state's energy conservation standard for new state buildings. Today's design community would consider the prototype that the extension was compared against to be fairly but not aggressively energy-conserving, Dr. Hunn said.

The Texas energy standard and the national standard from which it is adopted each have three methods for checking compliance (prescriptive criteria, performance-based criteria, and energy cost budget). Dr. Hunn said he believes that the Capitol Extension is the first building in the country on which the most sophisticated of the three methods, the energy cost budget, has been used. This procedure involves comparing the overall cost of energy rather than the energy itself.

The researchers performed a second analysis to see if ten of the building's energy-saving features qualified for funding through the Texas LoanSTAR Program, which finances energy improvements to state buildings. An agency repays a LoanSTAR loan out of the money

(Continued)

Energy-efficient features of the Capitol Extension

- Underground location (rock temperature remains between 60° and 75° year-round)
- Two to six feet of soil overlying most of the building
- Moderate skylight area
- No conventional windows except around columned rotunda
- Carbon monoxide sensors in parking areas to control ventilation fan levels
- Most building entrances underground

Energy features funded by Texas LoanSTAR

- Direct digital control system for thermostats
- High-efficiency fan motors
- Variable-speed drives for HVAC air handling units
- Insulation in underground walls, roof, and plenum under offices above top garage level
- High-performance, double-glazed skylights
- High-efficiency lighting, many fluorescent with electronic ballasts and prismatic lens covers
- Compact fluorescent fixtures for adjustable (power-level-down) lights
- Motion detectors in offices and conference rooms to turn off unneeded lights
- Dimmer controls on lights in auditorium and hearing rooms
- Master control system to schedule lighting as needed
- Electroluminescent exit lights
- Carbon dioxide occupant sensors for ventilation control in office and meeting areas

saved on its subsequent utility bills.

Based on Dr. Hunn's and Mr. Hitzfelder's simulation, all ten features qualify (see list) and are being included in the building, according to Lee Gros, who oversees Texas LoanSTAR in the Governor's Energy Office. Two other features were

added: electroluminescent exit lights and carbon dioxide occupant sensors for ventilation control. The cost of these extra twelve energy savers is estimated at \$1.25 million.

Dr. Hunn has been asked by the Governor's Energy Office to help make the renovation of the 1888

Capitol as energy-efficient as possible. The task will require "a lot of sleuthing around," he said, because no complete set of mechanical and electrical system drawings exists for the Capitol and its many add-ons and renovations through the years. ■

CES Update

Office of Director

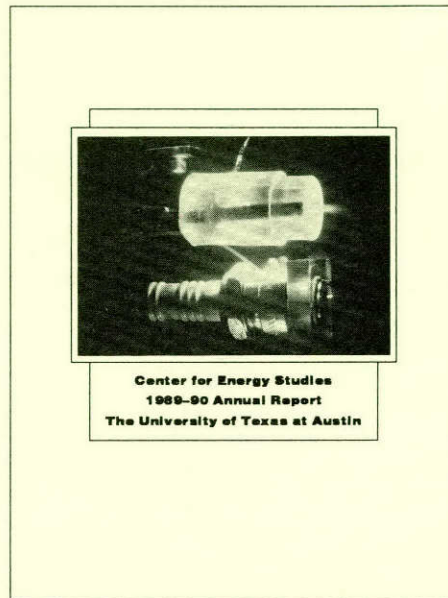
UT's solar car, the **Texas Native Sun, will race again.** A team of students is preparing for a 760-mile race June 18-23 from Sacramento to Los Angeles in the California Clean Car Race, CalCAR.

The group of 12 students is now raising \$37,000 to \$70,000 and modifying the car, according to Gary C. Vliet, professor of mechanical engineering, who is the group's advisor. The students plan to increase the battery capacity and improve the solar photovoltaic array that powers the vehicle.

The car originally competed in Sunrayce USA in July 1990, finishing 22nd of 32 university teams in the 1,600-mile race.

Donations have been granted by Central and South West Services (\$5,000), Austin Sheet Metal Association and Sheet Metal Workers Local Union 67 (\$1,000), Mechanical Contractors Association of Austin and Plumbers and Pipefitters Local Union 286 (\$1,000), and Center for Energy Studies (\$2,500). The UT Center for Research in Water Resources is providing work space for the project, and several UT faculty have contributed.

Two IBM **RISC System 6000 workstations** will be installed in April and May, one on the seventh floor of the Engineering Teaching Center for use by the combustion research group, the other at the Electromechanics and Energy Building at Balcones Research Center for use by other researchers. Both computers will be joined to the UT Ethernet network that links computers campuswide and beyond.



The **1989-90 annual report** of the Center for Energy Studies is available free upon request. The report describes the activities of the center and lists 222 publications by the 31 faculty, 120 students, and 40 research and administrative staff associated with the organization.

To receive a copy contact Beth Dunbar, Center for Energy Studies, The University of Texas at Austin, 10100 Burnet Road, Austin, Texas 78758 (telephone: 512/471-7792).

Combustion

The US Department of Energy and an industrial consortium have awarded **\$2 million to UT Austin researchers for an investigation of a new engine ignition device called the railplug.**

The railplug, a spin-off of Star Wars space technology, is a miniaturized version of a railgun. The railgun is a candidate technology for launching objects into space by applying

intense, short electrical pulses that travel down two parallel rails. Railguns have potential as antitank weapons as well.

The small cousin of the railgun, the railplug uses a similar but tiny pair of rails. Its plasma jet is more intense than a sparkplug's spark and can be used to ignite a variety of fuels in internal-combustion engines. According to tests by its inventors, the railplug's plasma jet improves combustion because it possesses more kinetic energy and more quickly penetrates and mixes the fuel and air.

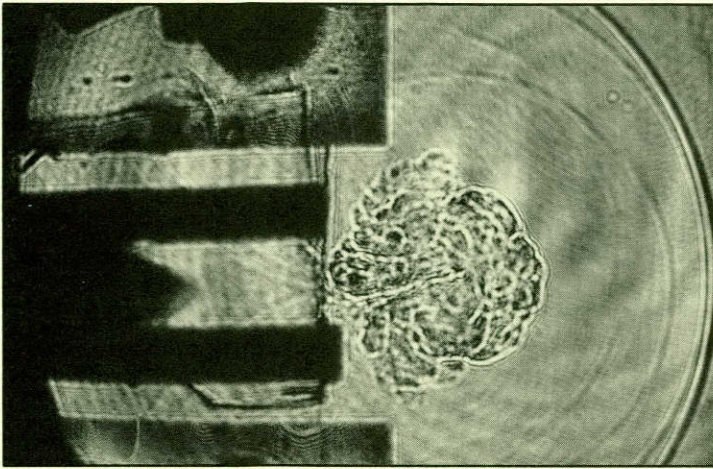
The new device shows promise as a way to develop lean-burn engines that give off less pollution and improve fuel economy, diesel engines that start easily in cold climates, and conventional engines that perform well on alternative and low-octane fuels. UT Austin has applied for a patent on the broad design and application of railplugs.

The project will be carried out jointly by the Center for Energy Studies and the UT Center for Electromechanics, a leading railgun research lab. The three-year contract is one of the largest ever awarded to the Center for Energy Studies.

The Advanced Energy Projects Division of DOE is providing \$1.5 million to the project, and \$500,000 comes from an industrial partnership of private individuals called RAI Railplug, Ltd., organized by Research Applications.

Mr. Mosier is president of Research Applications, Inc., formed three years ago by Frank McBee, a founder of Tracor, Inc., and several other members of UT's Engineering Foundation Advisory Council. RAI's primary focus, said Mr. Mosier, is to commercialize technology developed at UT and other Texas universities.

(Continued)



A shadowgraph image, taken with a laser, shows the explosive turbulence created by an energy burst from a railplug. The researchers have received \$2 million from DOE and private investors for the project.



Texas Land Commissioner Garry Mauro (center), UT professor Ronald Matthews (second from right), UT students, and sponsors March 25 discuss a truck the students are altering to run on natural gas.

RAI raised private funding for the railplug project and now is pursuing national and international patent rights and discussing alternative applications and sublicensing of the device with industry.

Mr. Mosier said he invites "companies with an interest in a better solution to engine ignition" to contact him. He is studying applications in large stationary engines, specialty burners, two-cycle engines, and alternative-fuels engines.

The research will include numerical modeling, combustion bomb experiments, proof-of-principle engine experiments, durability testing, and production-engine testing. Mr. Mosier said Champion Spark Plug, an active participant in the program, will be fabricating prototype railplugs and assisting in the area of plug durability.

Leaders of the project are three UT Austin mechanical engineering faculty: Ronald D. Matthews, associate professor; William F. Weldon, professor; and Steven P. Nichols, deputy director of the Center for Energy Studies. Prof. Weldon directs the UT Center for Electromechanics.

The project's advisory board includes senior representatives from Caterpillar, Inc.; Champion Spark Plug Company; Chrysler Motors Corporation; Defense Advanced Research Projects Agency; Ford Motor Company; Fort Belvoir Labs (US Army); General Motors; Los Alamos National Laboratory; Mercury Marine; and Southwest Research Institute, a leading automotive research center.

The advisory board met with the researchers April 11 and 12 in Austin

to discuss the railplug. "We asked for insights and expertise, based on the board members' experience. We were pleased with the results," said Dr. Matthews.

"The board really rolled up their sleeves and worked with our researchers," said Dr. Nichols.

Dr. Nichols said the DOE contract is a turning point in the development of the railplug, but it never would have happened without the industrial funding achieved by RAI and previous funding from the state's Advanced Technology Program and the UT Center for Energy Studies, College of Engineering, and Center for Technology Development and Transfer.

Working with a group like RAI has been fruitful for the researchers, according to Dr. Nichols. "UT does an excellent job of research, education, and public service. Universities are not currently set up to commercialize technology rapidly or easily. This [partnership with RAI] is a good mechanism to rapidly commercialize technology."



UT faculty and students held a news conference March 25 with Texas Land Commissioner Garry Mauro to discuss the university's entry in the upcoming "**Natural Gas Vehicle Challenge.**"

Commissioner Mauro, describing himself as an Aggie who is supporting UT Austin in this particular contest, told attendees that compressed natural gas vehicles (NGVs) such as the one the university team is customizing are superior to gasoline-

powered vehicles. "They make sense environmentally; they make sense in terms of national security."

"Natural gas is the cheapest automotive fuel available—bar none," he said.

His comments were made during the General Land Office's second Alternate Vehicle Fuels Symposium, which featured 75 exhibits and drew an estimated 1,200 attendees.

The NGV Challenge race is sponsored by the Society for Automotive Engineers, US Department of Energy, GMC Truck Division, Argonne National Laboratory, and other groups in the United States and Canada. The purpose of the race is to demonstrate the practicality of natural-gas-powered vehicles. UT Austin and 23 other colleges were each given a gasoline-type three-quarter-ton GMC Sierra pickup. They will modify the trucks to run on natural gas and compete for \$21,000 in prizes.

The UT team has developed a design that "nobody's ever tried before," said Ronald D. Matthews, faculty advisor to the student team and associate professor of mechanical engineering.

In natural-gas-powered vehicles, the emission that is difficult to control is oxides of nitrogen, NO_x . A usual approach to reduce NO_x is to flow extra air into the flame to cool it. According to Dr. Matthews, the UT design will cool the flame by recirculating exhaust gas into the intake manifold, an approach adapted from gasoline engine design.

The power losses from cooling the flame will be reclaimed with a me-

chanical supercharger with an inter-cooler.

The UT team must finish its truck by June 6 and drive it to Norman, Oklahoma. The trucks will be judged on their performance in emissions control, fuel economy, cold start, engine noise, dead-weight pull, and a road rally.

"Enrolling the talent and imagination of young engineers has long been part of technological development in the automotive industry," said Commissioner Mauro, whose state fleet is converting to natural gas. "When the [Society of Automotive Engineers], a noted lab [Argonne], and private industry take on a project like this, they are serious about the future of the technology.

"These engineering students will help open the door to cleaner air and less dependence on foreign oil. I wish them well."

The UT Austin team has 10 student members and one other faculty advisor, Steven P. Nichols, deputy director of the center. Sponsors of the truck are the Austin Sheet Metal Association and Sheet Metal Workers Local Union 67 (\$5,000), Banks Engineering (\$1,000 in equipment), Enron Corp. (\$5,000), Mechanical Contractors Association of Austin and Plumbers and Pipefitters Local Union 286 (\$5,000), GMC Truck Division and Hendrix GMC (race vehicle), Shell Gas Trading Company (\$5,000), Southern Union Gas Co. (\$3,150 and \$1,000 in equipment), Tren-Fuels, Inc. (\$2,700 in equipment), UT Center for Energy Studies (\$2,500), and College of Engineering.

■
Nitrous Oxide Systems, Inc., has donated \$17,500 to the combustion research group to support its research.

Environmental Solutions

Raymond C. Loehr, head of the new Environmental Solutions Program, which began operation in January, announced in early April that **nine companies have joined as sponsors.**

"This response shows the strength of the program," Dr. Loehr said. "We

are in final contractual negotiation stages with several other companies, and I'm sure the number of sponsors will grow."

The first group of sponsors consists of Air Products and Chemicals; ARCO Oil and Gas; Borden, Inc.; E. I. du Pont de Nemours; Exxon Production Research; Mobil; Neste Oy (Finland); Phillips Petroleum Co.; and Tennessee Valley Authority.

"The expectation is that we will have as many as fifteen sponsors for ESP by the end of 1991," said Dr. Loehr.

Sponsoring companies share the cost of the research program through a yearly membership fee. For a cost equivalent to that of one small research project, the sponsor receives early access to nearly all the results of a large pool of researchers, not just those directly funded.

In other program developments, Dr. Loehr announced that Vince Torres has been appointed manager of the program. Mr. Torres, a center research associate, is also manager of the Process Energetics Program.

A catalog of ESP research publications has been distributed to sponsors. The total number of published and unpublished technical documents in the catalog is 98.

The first meeting of the Environmental Solutions Program will take place May 9-10 in Austin. More than a dozen principal investigators and their graduate students will present results of their research to industrial sponsors.

For more information about the Environmental Solutions Program, contact Mr. Torres or Dr. Loehr at 512/471-7792.

Process Energetics

The head of the Process Energetics Program, **Philip S. Schmidt**, April 2 was surprised in his classroom and awarded the highest honor given by UT Austin students. The Friar Centennial Teaching Fellowship is awarded for distinction in undergraduate teaching.

Dr. Schmidt, who holds the Donald J. Douglass Professorship in Mechanical Engineering, is the first professor from a scientific or technical discipline to win the award of the Friar Society. He teaches courses



Philip S. Schmidt

primarily in thermodynamics and heat transfer.

Herbert H. Woodson, dean of engineering, who accompanied UT President William H. Cunningham in dropping in on

Dr. Schmidt in his classroom, said, "[Thermodynamics] is a difficult course, and anyone who teaches it so people can understand it is doing very well."

Dr. Schmidt also received a second honor from the university, the AMOCO Foundation Outstanding Teaching Award, which is awarded to two UT professors a year.

Separations

Five new sponsors have joined the Separations Research Program, bringing the number of sponsors to 33. The companies are ABB Lummus Crest, Gas Research Institute, M.W. Kellogg, Mobil Research & Development, and Solvay et Cie.

■
Separations researchers have begun to investigate **high-gravity distillation**, a method of separating chemicals by means of centrifugal force. An SRP sponsor, Glitsch, donated a pilot-scale high-g distillation unit that was put into operation in early April. The unit is made under the brand name Higeo.

A. Frank Seibert, technical manager of the program, said high-g distillation equipment is quite compact, allows faster throughput with a smaller volume than conventional distillation, and tends to be competitive for separating hazardous or high-value chemicals.

■
Chris L. Martin has joined the Separations Research Program as a research associate. Mr. Martin previously worked with the program as a student and research staff member and returns to UT Austin from Advanced Engineering Technologies. His areas of expertise are process control, distillation, and computer applications. ■

The University of Texas at Austin
 Center for Energy Studies
 Balcones Research Center
 10100 Burnet Road
 Austin, Texas 78758

Nonprofit
 Organization
 U.S. Postage
 PAID
 Austin, Texas
 Permit No.
 391

ADDRESS CORRECTION REQUESTED
 FORWARDING POSTAGE GUARANTEED

UT Austin Energy

UT economist expects Texas economy to remain stable after Gulf war

The Texas economy probably will remain stable after the end of the Persian Gulf war, even if the price of oil decreases, says an energy economist at UT Austin.

"Everyone is expecting a big glut in the oil market," says Mina Mohammadioun of UT Austin's Bureau of Business Research, "and it looks as if the price is going to go down to prewar levels or even lower. But I think several factors will insulate the Texas economy from much effect one way or the other."

Dr. Mohammadioun, who as a BBR economist has published numerous papers on oil prices, says the effects of lower prices on the Texas economy are likely to be offset by increased natural gas production in the state. Increased oil production may have added state revenues in recent months, she says, and now natural gas production will probably increase with the full implementation of the Clean Air Act of 1990.

"Most producers just tried to produce more from existing wells," she says, "so if they didn't start anything new, they should be able to decrease their production again without any negative effects."

Texas producers who took a chance and drilled new wells after oil prices skyrocketed in August probably will be hardest hit, she says, but apparently few new wells exist.

Because the Texas economy is



UT Austin and Capital Metro are running an eight-week experiment with a free open-air tram powered by propane. The shuttle, METRAM, a red-and-white 48-seat trolley, has proven popular among students in its first weeks of operation in March on the UT Austin campus.

more diversified than it was in the 1980s, the lower price of oil will not affect the state's economy in dramatic ways, Dr. Mohammadioun says. An unexpected windfall that could help Texas will be the need for Kuwait to rebuild its oil fields.

The oil glut, however, will probably continue to depress the price of Texas oil for the next several months, she says. "It's going to take time for OPEC to reestablish control of their own output."

Energy, environmental short courses offered at UT

Short courses on energy and environmental topics will be taught

by UT engineering faculty members in the spring and summer through Continuing Engineering Studies of The University of Texas at Austin:

- *Clay Liners and Covers for Waste Disposal Facilities*, May 29-31 in Los Angeles; repeated June 12-14 in Austin; July 8-10 in Boston; David E. Daniel
- *Power System Harmonics*, in Austin June 3-5, W. Mack Grady
- *Fundamentals of Electric Power System Engineering*, June 10-14, W. Mack Grady

For information contact Continuing Engineering Studies, The University of Texas at Austin, Austin, Texas 78712, 512/471-3506. ■