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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

Future Landscapes of the Colorado Plateau

[The Colorado Plateau—the region where Utah, Colorado, New Mexico, and Arizona intersect—contains many of the United States' greatest national parks: Grand Canyon, Bryce Canyon, Zion, and a number of others. It also contains some of the richest deposits of coal, oil shale, and uranium in the country.

The future of the beautiful and energy-rich Colorado Plateau thus has become a politicized subject, one involving many competing interests and interrelated subissues. Volumes of analysis, opinion, and comment are written about it.

The following excerpt is adapted from a forthcoming CES report that attempts to summarize these controversies, Future Landscapes of the Colorado Plateau: Impacts of Energy Development. *The authors are Dr. Robin Doughty, UT associate professor of geography, and Dr. William E. deBuys, who recently received his doctorate in American Studies. Their research was funded in part by the Center for Energy Studies.]*

Development of coal, uranium, and oil shale reserves will create new industries and new environments both physically and socially, throughout the American West. One region in particular will be affected, the Colorado Plateau, which comprises portions of New Mexico, Colorado, Utah, and Arizona. Already the plateau has seen two major postwar energy booms, one of uranium exploration in the late forties, the other of oil and gas development in northwest New Mexico during the fifties. Exploitation of the region's enormous coal reserves began with the construction of New Mexico's Four Corners Generating Station in 1963, but has progressed only fitfully since then.

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The Colorado Plateau

Uranium
Coal
Oil Shale
Oil
Natural Gas
Power Plants

National Forests
National Wildlife Refuges
Indian Reservations
National Parks

The region now expects booming growth in both coal production, which is likely to increase severalfold during the present decade, and the production of oil from shale, a nascent industry, which, in spite of its current ills, may nonetheless begin to contribute substantially to the nation's energy supply sometime early in the twenty-first century. Uranium mining and milling may or may not experience further growth, depending on whether new demand develops for domestic nuclear power.

The changes brought on by industrialization will be so pervasive that they will affect nearly every aspect of the biophysical life of the region, from air quality and weather patterns to the hydrology of deep underground aquifers. And the human environment will be equally affected. The present boom in energy development on the Colorado Plateau is attracting and will continue to bring unprecedented numbers of people to work on mine sites, at energy-processing and electricity-generating facilities, and in other establishments that sustain and service the energy industry. These relatively well-paid workers will add new suburbs and strings of trailer parks to existing communities, and they will also inhabit new company towns, spilling into what has been traditionally an empty and rural environment. New residents are likely to overextend municipal facilities and bring additional pressures to bear on surrounding environments by using off-road vehicles for recreation.

The industrial boom that is occurring in many places on the Colorado Plateau (notably in coal-rich locations) consists of more than rapid urban growth. Extractive activities are directly transforming the geomorphology, hydrology, flora and fauna, and air quality of the plateau's life-support system. Earth-moving equipment, explosives, and mining machinery make it practical to level mountains, fill canyons, and clear mesas of woodlands and shrubs in order to expedite the removal of coal, oil, and other minerals. Development of the plateau's energy could very well produce a flood of change that will alter everything that has gone before.

It is possible that federal and state laws will help to cushion the environment and the region's peoples from haphazard and unforeseen shocks from energy development. However, so abundant and widespread are coal, oil shale, and uranium supplies that extracting them will involve new and large-scale methods of operation. The long-term impacts of these methods on the Colorado Plateau's environments are undetermined.

How much energy will be extracted from the plateau depends on market forces. Experts agree that the region is enormously rich in energy resources, but there is no consensus about how much of this energy will be required over the next two or three decades to meet regional and national demands.

The landscape of the Colorado Plateau can be viewed as a kind of text that people interpret differently according to the different emphases that they place on its various natural and cultural resources. The Navajos regard their nation as sacred space, but are willing to develop its resources in order to gain self-sufficiency and prosperity. Environmentalists regard the sweeping lonely mesas, isolated buttes, and twisting canyonlands as beautiful, varied, and unique places where the nation's natural heritage must be protected. Ranchers see the plateau's open ranges as an economic opportunity and have maximized the benefits they derive by eliminating rodents that compete for forage and predators that kill their stock. They will accept new industry for their children's sake. Industrialists value the plateau's subsurface resources—its abundant coal, oil and gas, oil shale, and uranium—and they argue that they must extract these vital sources of energy if this nation is to maintain its prosperity and become self-sufficient in energy.

Today, this latter perception of the Colorado Plateau is dominating other concerns. It is clear that in the next ten or twenty years the plateau will experience many changes due to a boom in energy development. The plateau is a microcosm for future energy activities in the West, and this study is a primer for examining change. By using the term *landscape* in an ecological and cultural sense, we have endeavored to identify the important variables that will be affected most by energy development and have examined the issues that energy activities will create. Our purpose is not to add stridency but to present a synthesized vision that will help to promote understanding of a complex topic. The need to meet this nation's demand for energy requires a broad perspective, one that considers other values beyond economic ones. To view the future of the Colorado Plateau as a simple conflict over development versus preservation is far too superficial. The leaders who confront the issue of residual effects on the environment, physical beauty and other amenities, and ethnic conflicts must attempt to resolve these issues, not pretend that they are unimportant or nonexistent. This study of the cultural landscape of the Colorado Plateau suggests a method for examining more than the material requirements of an acquisitive society. The cultural landscape includes qualities that more and more people consider important to what we euphemistically call "mental health"—the person's need for repose, solitude, and silence in the presence of open, unsullied, and wild scenery.

The Colorado Plateau's cultural landscape is also this nation in miniature in its history of transforming wild places. Our activities there reflect our historic drive toward taming the landscape of North America. Today we have proved that not only is conquest of the environment possible, it is accomplished; indeed, so successful have we been in this conquest that natural beauty is clearly becoming as finite and treasured as the material resources that have given us our prosperity. Accordingly, rather than regard wilderness with a Puritan hostility akin to the drive to produce order out of chaos, we must recognize that wilderness is a distinctive national asset, not a liability. Therefore, in occupying and transforming the Colorado Plateau, one of the most remarkable natural areas in the lower forty-eight states, we must be carefully, perhaps extraordinarily, diligent in minimizing deleterious changes, so that we do not close out options for those generations still to come.

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CES Update

Office of the Director

A UT professor of transportation is developing **a method to determine how fuel efficient the traffic system of a city is.**

Cities vary widely in this regard, said Dr. Robert Herman, who is also a professor of physics. Cars in London, for example, tend to drive at a slow average speed and to spend much time stopped and idling. Both these actions waste gasoline. On the other hand, in cities like Milwaukee and Melbourne, cars drive in a freer traffic flow, with much less stopping and starting.

How to put meaningful numbers on these differences and use them to analyze urban traffic is a formidable task. Many factors affect cars driving in urban traffic: traffic jams, speed limits, narrowness of streets, accidents, breakdowns, weather conditions, driver habits, timing of lights, merging patterns, intersection patterns, and many, many others. The problem is so complex and the variables so numerous that a full description seems extremely difficult, Dr. Herman said.

Since 1956, at the research laboratories of General Motors and later at The University of Texas at Austin, Dr. Herman has been considering, testing, and researching a flow theory to describe urban traffic. One of the principal discoveries he has made is to identify the presence of collective effects.

"You can write down a long list of factors—and find out that, because of collective effects, there may be a simple linear relationship, explained by one single variable: trip time," Dr. Herman said.

Data on fuel consumption versus trip time (per unit of distance) have been gathered under different traffic conditions in cities around the world. When displayed graphically, all of the observations lie within a relatively narrow linear band, indicating that the longer the trip time for a given distance, the more fuel is consumed per unit distance.

In his most recent research project, sponsored in part by the Center for Energy Studies, a car will be equipped for accurate fuel measurement and driven in a series of tests in Austin, San Antonio, and perhaps Dallas and Houston. The trips will occur during the traffic peaks in the morning, noon, and evening and during the periods in between. Aerial photographs will be used to check the data gathered in the car.

Geothermal Studies

Dr. Myron H. Dorfman, head of the Geothermal Studies Division, has been named **director of the Texas Petroleum Research Committee** (TPRC), the research arm of the Texas Railroad Commission.

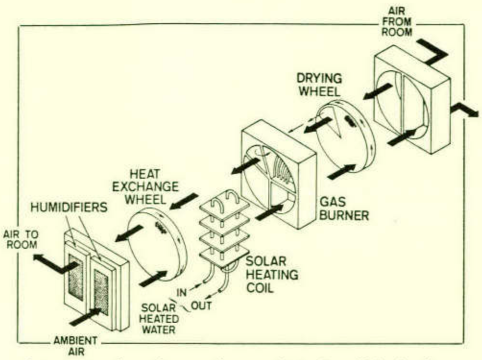
Texas Petroleum Research Committee research is conducted by University of Texas and Texas A&M petroleum engineering faculty and students. It emphasizes reservoir geology and engineering for enhanced oil recovery from existing fields in Texas.

Dr. Dorfman, who is also chairman of the UT Department of Petroleum Engineering, said he plans to enlarge the scope of TPRC research to include revision of regulations for petroleum drilling, completion, and production, as well as the environmental effects of drilling fluid disposal.

Solar Studies

Solar Division researchers have developed a set of performance charts for the **solid desiccant rotary dryer,** a system that can use solar heat to dry large volumes of air.

Solid desiccant rotary dryers are used in coastal industries to dehumidify the air in working spaces, said Dr. Gary Vliet, head of the Solar Division and director of the investigation. Research assistant Joe Britt Ingram conducted the research as his master's project in mechanical engineering. Earlier work was done by Fernando Pla-Barby as the topic of his PhD in mechanical engineering under Dr. Vliet.



An example of a solar-assisted solid desiccant rotary dryer, the Solar MEC Unit, designed by A. B. Carl Munters.

As the accompanying picture shows, a solid desiccant dryer consists of a rotating drum or wheel divided into two parts. Moist air passes through one section of the drum and over the desiccant material it contains. The desiccant material becomes moist as it absorbs water from the air, and warm dry air exits. The drum then rotates, moving the desiccant over to a region of heat, where heated air drives off the moisture, thus regenerating the desiccant. (This air would be heated by solar or other thermal energy.) The desiccant in each half of the drum alternately repeats this cycle so that a continuous stream of dry air is produced.

The researchers created a set of performance charts to describe how the system performs under different operating conditions. The charts are useful in adapting a unit to a new application and in designing new models, Dr. Vliet said.

The design charts assume that the rotary dryer system will be used with flat plate collectors of typical design parameters fixed at optimum. Because heat from flat plate collectors reaches only 200°F at best, the system thus requires more area for regenerating the desiccant than for air drying. The researchers found the optimum ratio to be approximately 60:40, regeneration area to air-drying area. The amount of area needed for regeneration is considerably larger than that required if the regeneration temperature were higher.

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ADDRESS CORRECTION REQUESTED

UT-Austin Energy

Water Problems of Deep-Basin Lignite Mining Investigated

If deep-basin lignite is ever mined in Texas, water will be one of the major problems to overcome.

Two UT civil engineering faculty members, Drs. Randall Charbeneau and Stephen G. Wright, are researching the water-related difficulties of mining Texas' abundant deep lignite reserves. The project is funded by the Texas Energy and Natural Resources Advisory Council and sponsored by the UT Bureau of Engineering Research and the Center for Research in Water Resources.

As the accompanying map shows, lignite occurring at depths of 200 to 500 feet is found in East and South Texas. This deep lignite naturally will be more expensive to mine than the lignite found at shallower depths; thus it is not expected to become economically attractive until the year 2000 or later, Dr. Charbeneau said.

Two methods of deep mining have been proposed: (1) strip mining, in which first the overburden (the intervening layer of earth and rock) is removed, then the buried lignite; and (2) in situ gasification, in which the lignite is ignited in place underground and partially burned to produce a gaseous fuel.

To make deep strip mining feasible, dewatering the mining area with a system of wells would be necessary, Dr. Charbeneau said. Otherwise the water-saturated slopes of the pit would be unstable, tending to slide into the open pit and endangering the heavy mining equipment. Partial dewatering might also be necessary to improve efficiency of in situ gasification.

Drs. Charbeneau and Wright are seeking preliminary answers to questions such as:

—How far away will dewatering affect private water wells and irrigation?

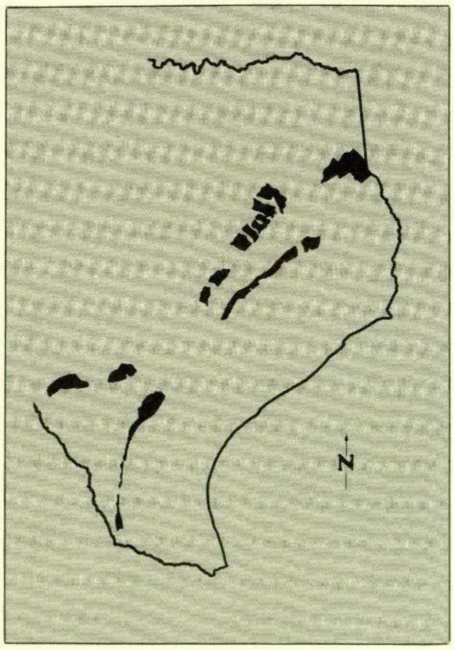
—How much subsidence will in situ gasification cause?

—How can the small river created by dewatering best be used for the duration of the mining project?

—How will pollutants travel in the groundwater away from the mining site?

—To what extent is a muddy soil easier to dewater than a sandy soil?

—Which technique, surface or in situ gasification, is best for hydrological reasons?



Location of deep-basin lignite in Texas (Adaped from W. R. Kaiser and others, Lignite Resources in Texas, *UT Bureau of Economic Geology, 1979)*