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EPA

Energy, Minerals, Industry

Energy from the West

Summary Report

The Energy/Environment R&D Decision Series

Some of the most basic problems facing our society today involve the use of our energy resources and the effects of this usage on our environment. These problems affect everyone, and everyone has an interest in their resolution. But the technical aspects of these problems make it difficult for a major portion of the interested public to understand and participate in the decision-making process. This volume contributes to the bridging of this information gap.

The Energy/Environment R&D Decision Series was inaugurated late in 1976. The series presents, in an easily understood and informative manner, selected key issues and findings of the Federal Interagency Energy/Environment Research and Development Program, which was initiated in fiscal year 1975. Planned and coordinated by the Environmental Protection Agency (EPA), the Interagency Program sponsors more than 1,000 research projects ranging from the analysis of health and environmental effects of energy systems to the development of pollution control technologies.

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Energy From the West

Summary Report

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Foreword

The development of energy resources inevitably impacts Man and his Environment. The nature, magnitude and distribution of these impacts must be thoroughly understood if balanced judgments concerning future energy development in the United States are to be made. The Office of Energy, Minerals and Industry (OEMI), in its role as coordinator of the Federal Energy/Environment Research and Development Program, is responsible for producing information on health and ecological effects and on how to mitigate adverse effects. This information is critical to developing the Nation's environmental and energy policy. Within the OEMI, the Integrated Assessment Program combines the results of Energy/Environment Program research projects and analyses of the socioeconomic and political/institutional aspects of energy development in policy-oriented studies. These studies are undertaken to identify the tradeoffs among alternative energy technologies, development patterns, and impact mitigation measures.

This report summarizes the results of a three-year Technology Assessment of Western Energy Resource Development, a study which examined the development of coal, geothermal, natural gas, oil, oil shale, and uranium resources in an eight-state area in the western United States (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming). Three previously published project reports provide detailed background information on the six energy resources, development technologies, and laws and regulations *(Energy From The West: Energy Resource Development Systems)* and report the results of site-specific and regional impact analysis *(Energy From The West: Impact Analysis Report)* and the analysis of nine major policy problems and issues *(Energy From the West: Policy Analysis Report).*

These project reports are being distributed at a time when western energy resources and synfuels technologies figure prominently in national energy policy. The three major *Energy From The West* reports identified above were designed to provide both interested citizens and professionals interested in energy resource development a set of planning handbooks for identifying and evaluating energy resource developments ranging from a single facility to the large-scale regional production of a variety of resources and fuel types. Our hope is that this summary report will whet your appetite and that you will want to examine and use the other three reports.

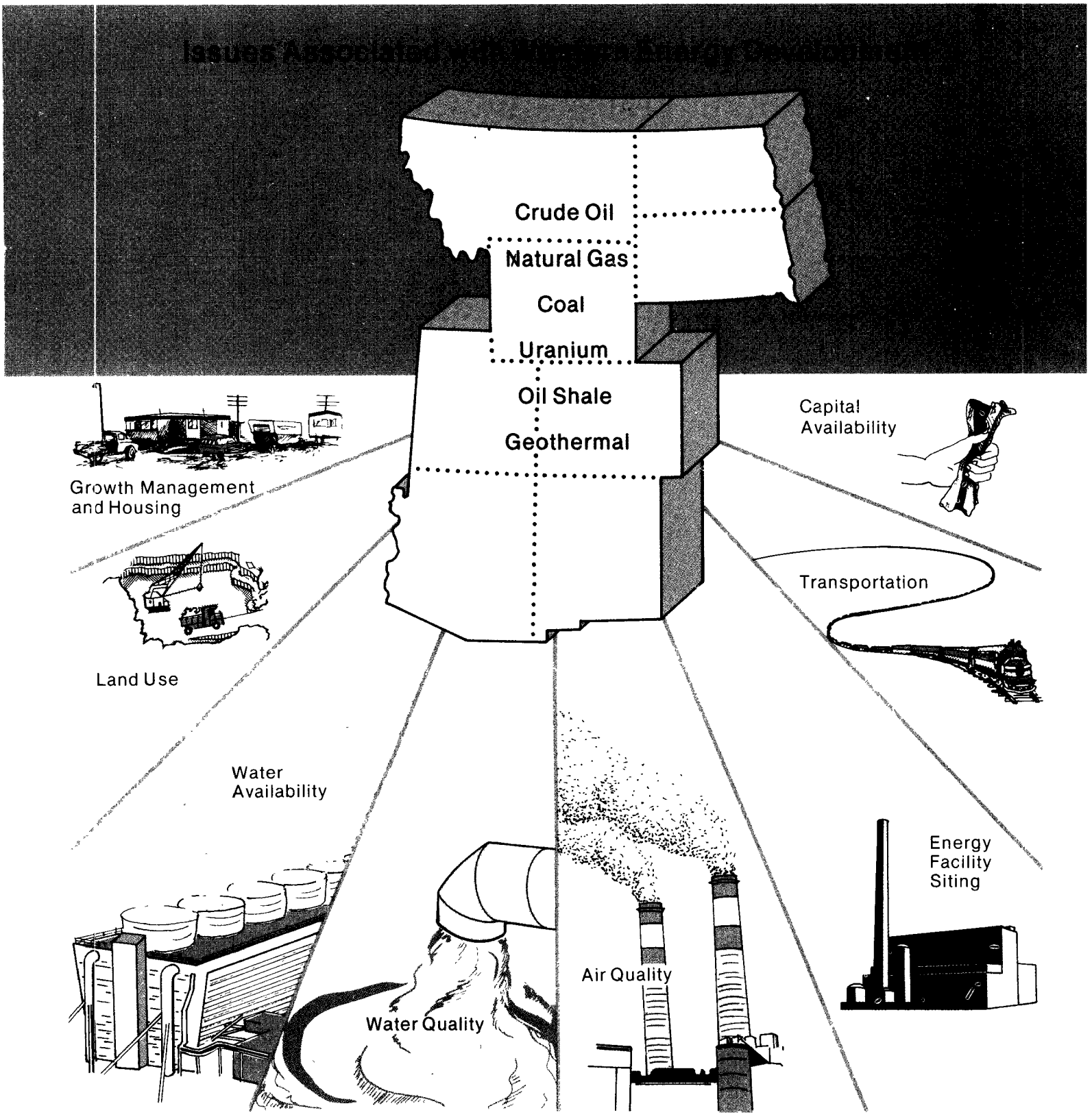
Your comments and suggestions concerning all four reports will be welcomed.

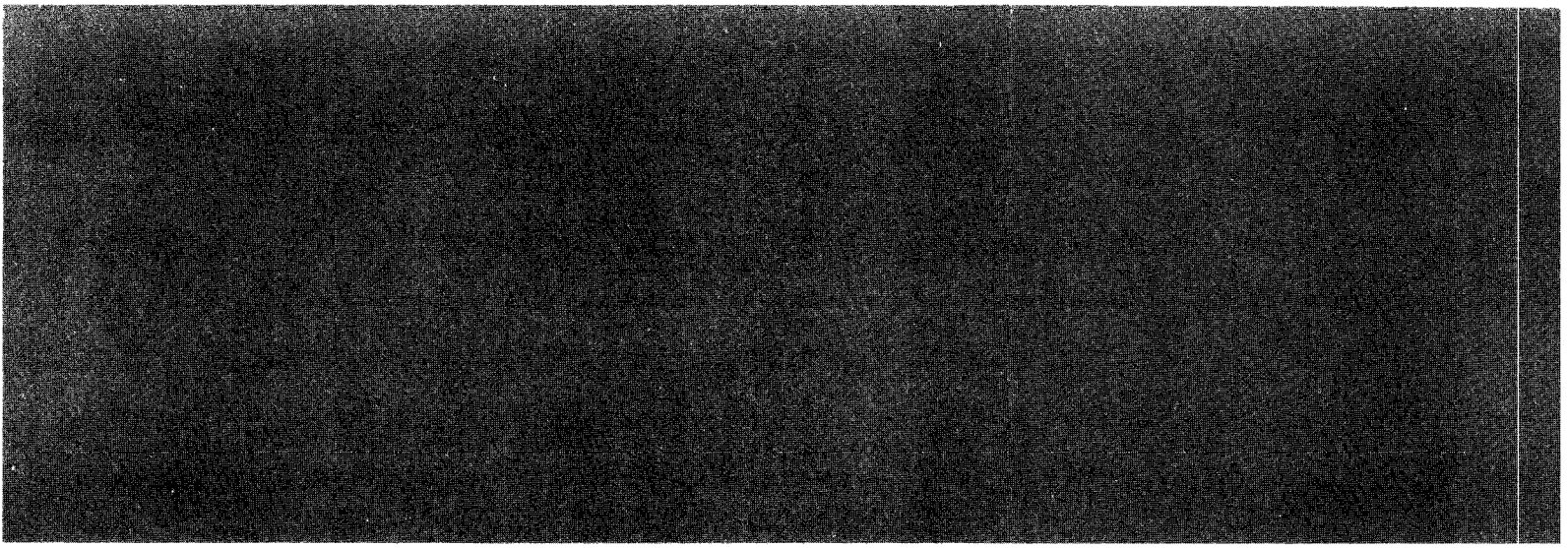
Steven R. Reznek
Deputy Assistant Administrator
for Energy, Minerals and Industry

Preface

This summary report has been prepared as a part of "A Technology Assessment of Western Energy Resource Development" conducted by an interdisciplinary research team from the Science and Public Policy Program of the University of Oklahoma for the Office of Energy, Minerals and Industry (OEMI), Office of Research and Development, U.S. Environmental Protection Agency (EPA). This study was conducted under the Integrated Assessment Program established by OEMI in 1975. Recommended by an interagency task force, the purpose of the Program is to identify economically, environmentally, and socially acceptable energy development alternatives. The overall purposes of this particular study are to identify and analyze a broad range of consequences of energy resource development in the western U.S. and to evaluate and compare alternative courses of action for dealing with the problems and issues either raised or likely to be raised by development of these resources.

Radian Corporation, Austin, Texas, and Martha Gilliland of Energy Policy Studies, Inc., El Paso, Texas, have been major contributors to this study, especially in terms of the environmental impact analyses. Other major contributors include Water Purification Associates, Cambridge, Massachusetts, who conducted studies of water requirements for energy facilities; and the Center for Advanced Computation, the University of Illinois at Urbana-Champaign, who conducted a study of the costs of alternative energy transportation modes. Don E. Kash, former Director of the Science and Public Policy Program and now serving as Chief of the Conservation Division of the U.S. Geological Survey, assisted the team in a number of ways.

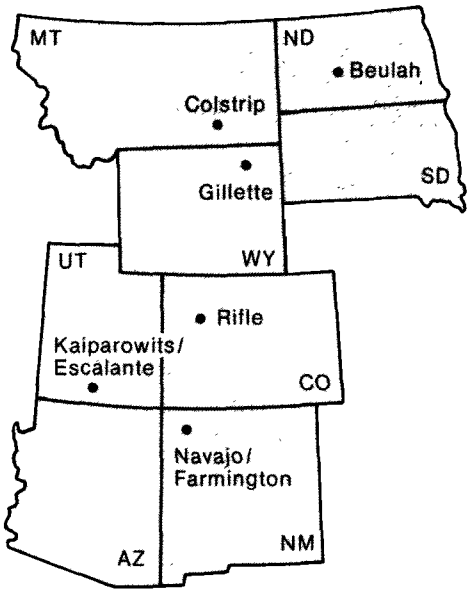

Crude Oil
Natural Gas
Coal
Uranium
Oil Shale
Geothermal
Growth Management and Housing
Capital Availability
Land Use
Transportation
Water Availability
Energy Facility Siting
Air Quality
Water Quality



Introduction

Significantly increased domestic energy production will almost certainly include the large-scale development of energy resources located in the western U.S. Recognizing that the development of these resources will produce a broad range of economic, environmental, social, and other impacts, this technology assessment was initiated by the Environmental Protection Agency (EPA). Its purpose is to identify the problems and issues that need to be addressed if western energy development is to proceed in a manner in which beneficial opportunities are maximized and negative consequences minimized.

The primary objective is to produce results that will help EPA to revise and/or initiate and implement appropriate environmental control policies and programs. Study results are also intended to be useful to other federal agencies and officials, the Congress, state and local governments, energy developers, labor, environmentalists, Indians, and a broad range of other parties whose interests and values are likely to be affected by the development of western energy resources.



Eight-State Study Area and Six Site-Specific Scenarios

found in Colorado, Utah, North Dakota, and Montana. Areas of geothermal resources are still being discovered, but have been primarily identified in the western half of the region.

Energy development and the resulting impacts were studied for two region-wide scenarios and for local scenarios at six sites. Each of the six site-specific scenarios combined representative local conditions (such as topography, meteorology, population, and community services and facilities) with a variety of energy development technologies.

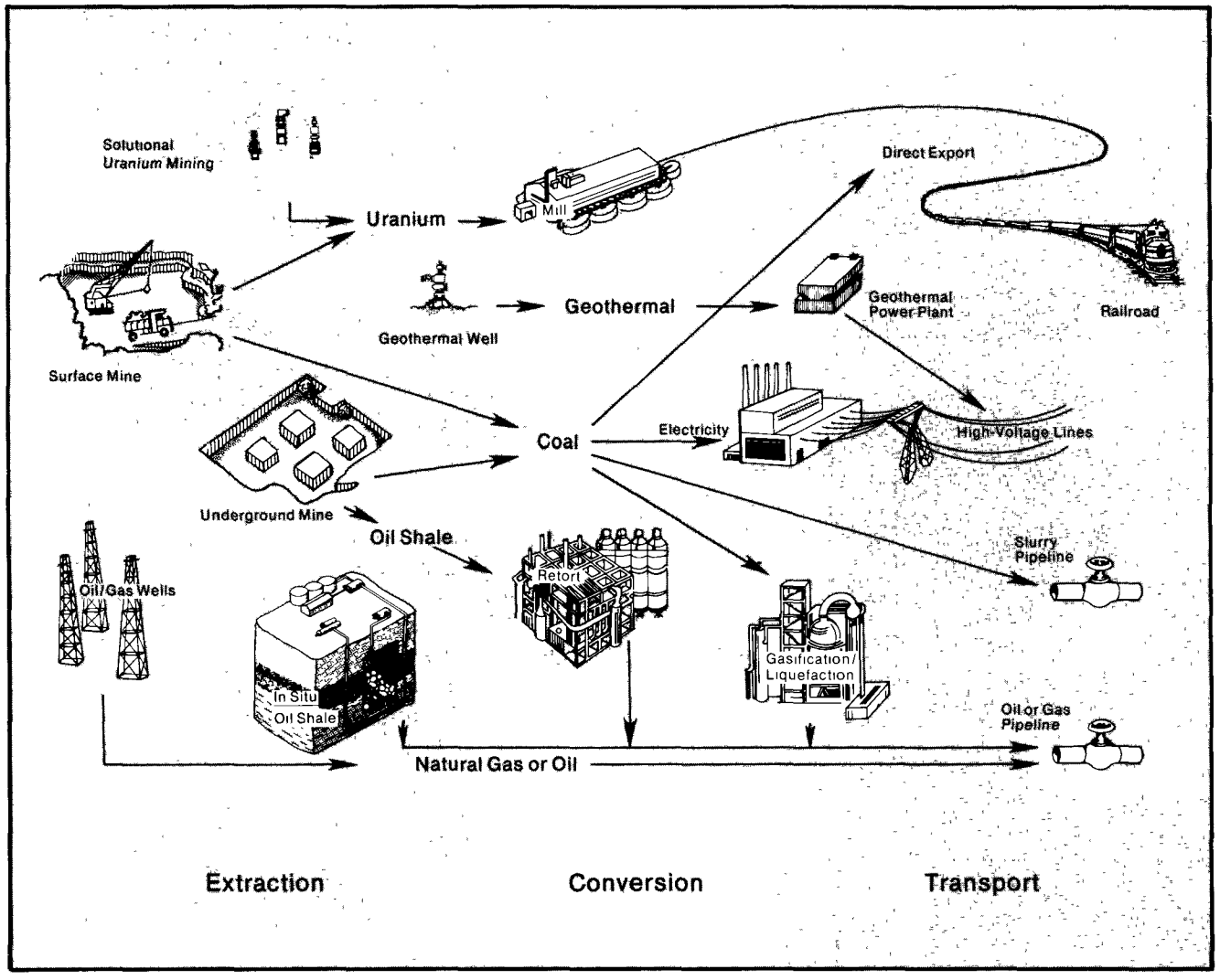
Scope and Approach

The study includes eight Northern Great Plains and Rocky Mountain States and six energy resources. Coal is found in all eight states with the largest concentrations occurring in the Northern Great Plains. The highest grade oil shale deposits occur in the Green River Formation in Colorado, Utah, and Wyoming. New Mexico and Wyoming contain the largest deposits of uranium, although some uranium may be found in each of the eight states. Crude oil and natural gas reserves are largest in New Mexico and Wyoming, although significant amounts of these resources are also

Energy Resources Studied in Eight Western States

Resources	Reserves (Q's)	Percent of U.S. Total
Coal	3,430	36
Oil	12.2	6
Natural Gas	19.9	8
Oil Shale	464	≈ 100
Uranium	246	90
Geothermal	650	22

One Q = 172 million bbls of oil, or 60 million tons of coal, or 1 trillion cubic feet of natural gas.



Energy Resource Development Alternatives

These alternative technologies were assessed:

- *Surface and underground mining*
- *Exporting of raw coal*
- *Coal-fired steam electric power generation*
- *Liquefaction and gasification of coal*
- *Surface and modified in situ retorting of oil shale*
- *Mining and milling of uranium ore*
- *Conventional and enhanced crude oil production*
- *Geothermal electricity production*
- *Energy transportation by rail, pipeline, and high voltage transmission lines*

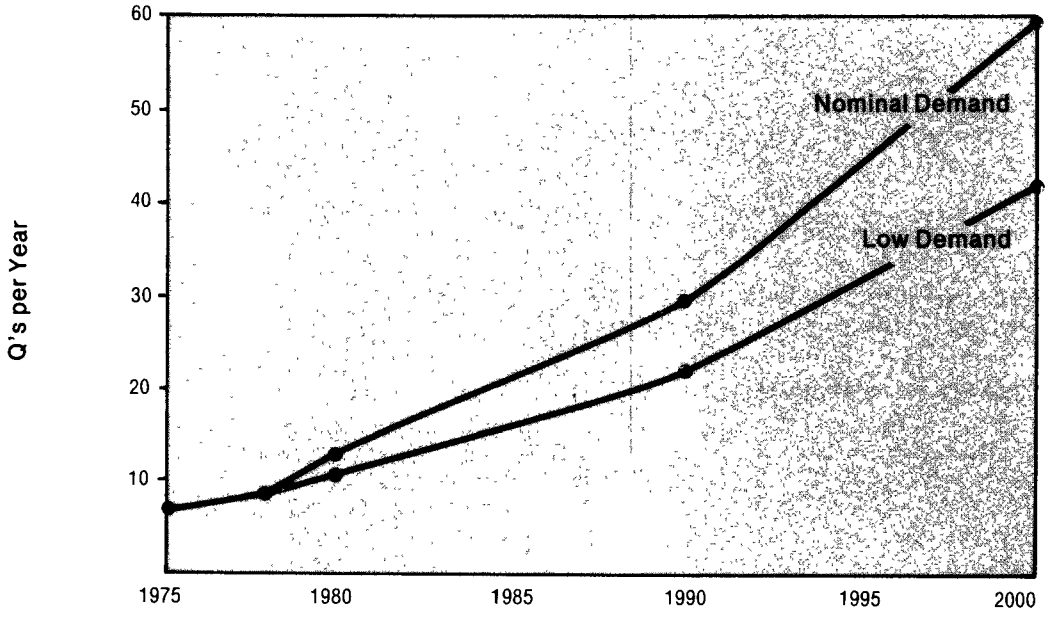
For a description of these extraction, conversion, and transportation technologies, as well as the laws and regulations affecting the development of each resource, see our report on *Energy Resource Development Systems* (complete citations are at the end of this report).

Two regional levels of development were assumed for the eight-state study area based on low and nominal national energy demand levels.

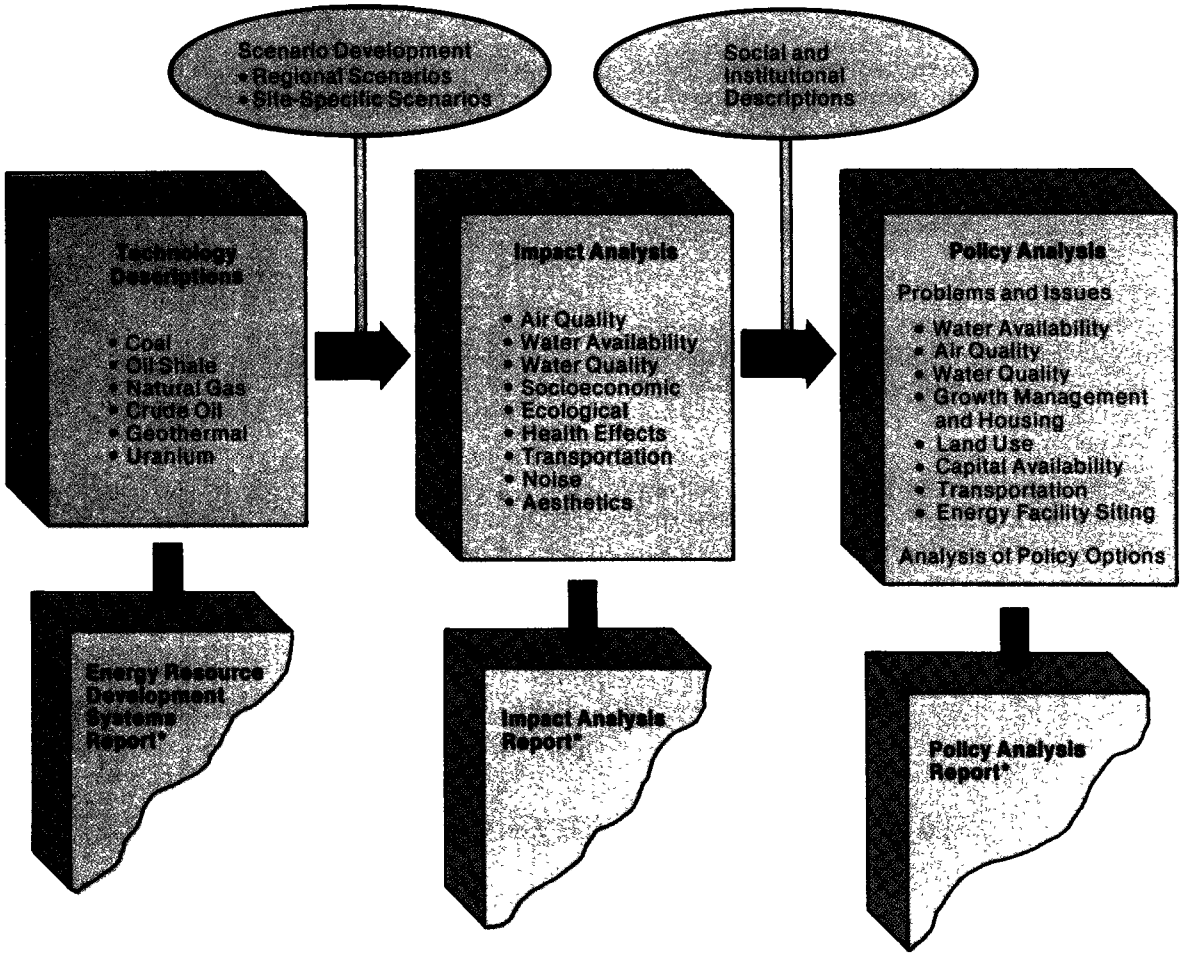
Site-specific and regional impacts resulting from the development of these energy resources from the present to the year 2000 have been analyzed. Eight categories of impacts have been identified:

- *Air*
- *Water*
- *Socioeconomic*
- *Ecological*
- *Health*
- *Transportation*
- *Noise*
- *Aesthetics*

Energy Production Levels in the Eight States



Study Approach



Findings are reported in the *Impact Analysis Report*.*

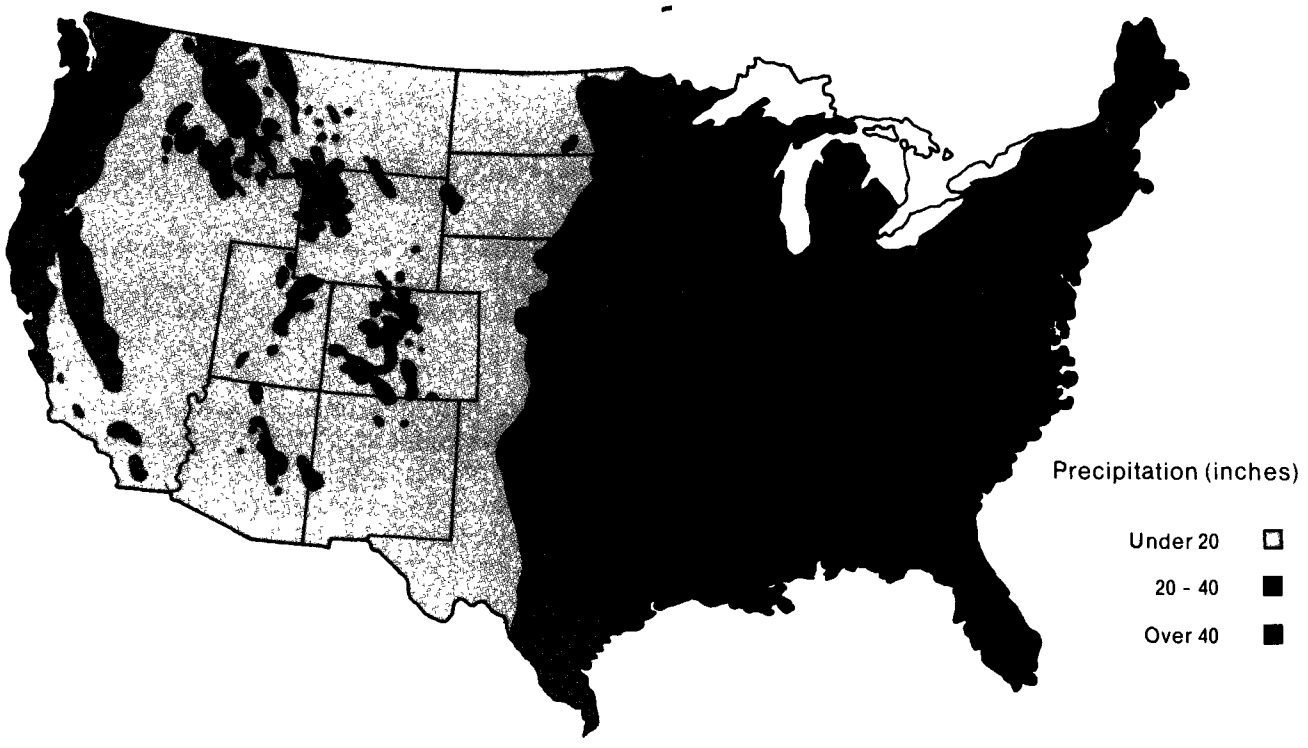
Following the impact analysis, we identified problems and issues that need to be addressed if western energy development is to proceed so that benefits are realized while negative consequences are minimized. Eight categories of problems and issues were analyzed:

- *Water availability*
- *Air quality*
- *Water quality*
- *Growth management and housing*
- *Land use*
- *Capital availability*
- *Transportation*
- *Energy facility siting*

For each category, policy alternatives were identified, evaluated, and compared according to several criteria. The results of this work are reported in detail in our *Policy Analysis Report** and are summarized below.

*Complete references for this and other publications from the study can be found on the final page.

Annual Precipitation



The Context of Western Energy Development

Several factors will be important influences on western energy resource development. Among the most important of these are the following: international factors such as the world price of oil; public attitudes about the energy crisis and the public's willingness to modify behavior and lifestyles; institutional arrangements for policymaking, particularly intergovernmental and public/private sector relationships; and the inadequacy of existing knowledge regarding the performance of new energy technologies and the impact of energy resource development.

While each of these factors will be important to energy policymaking, perhaps the most critical is the fact that energy problems are directly linked with economic and environmental problems and that policies intended to solve problems in one area will affect problems in the other two. Because of this interdependence, energy, economic, and environmental conflicts have arisen which have increased the uncertainties about how much, where, and in what manner domestic energy resources will be developed. As a result of these interrelationships and uncertainties, policymakers often find that attempts to deal with a problem at one point in the system produce problems somewhere else. Thus, policies and programs are often contradictory and are often challenged by other participants in energy policymaking.

Within this overall national context, western energy resource development is affected by regional factors. Among these considerations, none is more important than the general nature and character of the region, including the following elements:

- Although rich in natural resources, the region is water-short. Precipitation levels range from less than 10 inches in the desert Southwest to 10-20 inches in the Northern Great Plains region.

- With the exception of several large metropolitan areas (Albuquerque, Denver, Phoenix, Salt Lake City, and Tucson), it is sparsely populated.

- Approximately 45 percent of the total land in the eight-state study area is owned by the federal government and Indian tribes. The federal government owns about half of the coal, geothermal, and uranium and about 80 percent of the oil shale resources in the area. Indian tribes own an estimated 40 percent of the nation's uranium and 30 percent of all strippable western coal.

- Agriculture, mining, tourism, and government service are the major sectors of economic activity. Manufacturing employs more than 10 percent of the labor force in only three states: Arizona, Colorado, and Utah.

- Rugged individualism is still highly valued and government intervention is generally strongly opposed.

- Attitudes toward energy resource development range widely from being strongly supportive to strongly opposed. Much of the opposition by environmental groups comes from residents outside the region who wish to see the natural beauty protected.

These characteristics will continue to be important influences on national and state policies toward energy development, particularly in the area of intergovernmental relationships. The western states have strongly stated their intentions to have a major voice in the development of their region, and several areas of state-federal conflict have arisen. Questions about the extent of state authority in the allocation of water resources, implementation of federal air quality regulations, and control over reclamation on federal lands are among the most important areas of conflict.

Rancher Fearful of Development

A rancher outside Colstrip, Montana articulately expressed his fear of new energy facilities. "To me, I just don't think you can put a material value on what we have right here. I think it's our responsibility to do with it what we can and turn it over to our children in good shape. . . Then you get conversion plants, and you think, okay, what's this going to do with the water? How much water is going to come out of the Yellowstone? What's a 200 or 1,000 percent increase of the population of my hometown going to do?. . . To the tax base? . . . To the sociological undercurrent?. . . To my community? . . . "

—Johnson, Haynes. "The Last Round-Up." *Washington Post*, August 3, 1975, p. C-5. Quotes from Willie MacRae.

Water Availability

Problems and Issues

Energy development in the western states, particularly electric power generation using wet-cooling technologies, will add to current water availability problems and intensify existing political conflicts regarding water resource management. The most important water availability issues appear to be the following:

- **Water Shortages in the Colorado River Basin:** When energy requirements for water are added to nonenergy requirements for the year 2000, the total exceeds minimum availability estimates by as much as one million acre-feet per year. Even using the most optimistic combination of these estimates of water requirements and availability, energy resource development will consume a large percentage of unappropriated surface water.

Yellowstone Moratorium

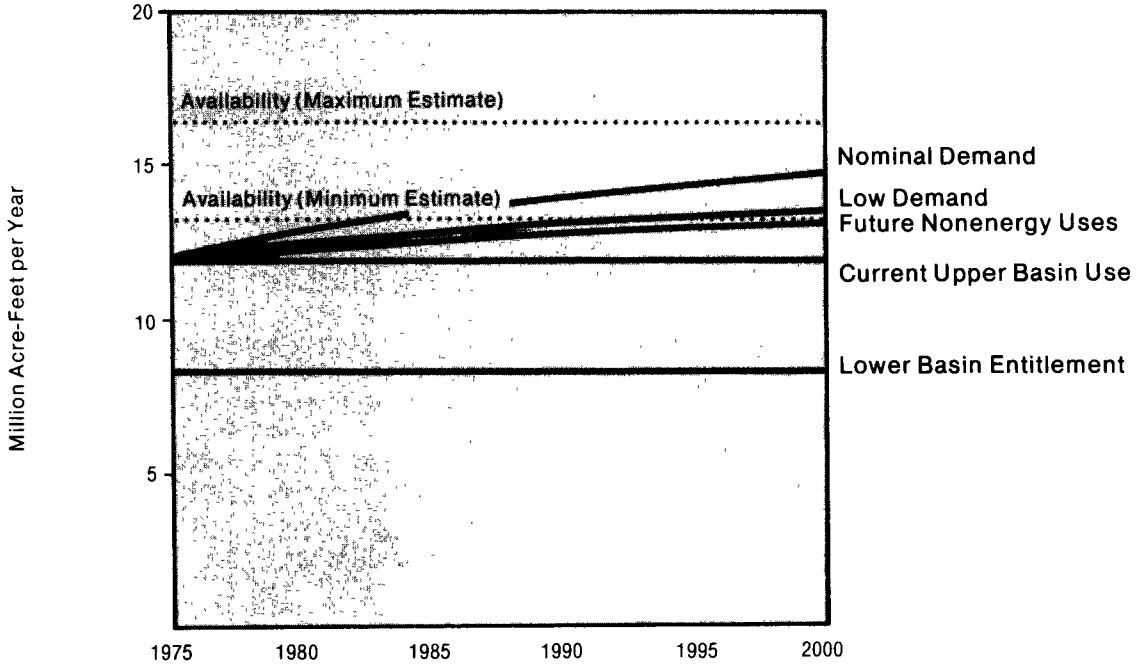
The State of Montana placed a four-year (March 1974 to January 1978) moratorium on new water rights from the Yellowstone in order to sort out existing rights and demands. Requests for rights have included 8.8 million acre-feet by coal related industrial users, 8.6 million acre-feet by the State Health Department, and 8.2 million acre-feet by the State Fish and Game Commission.

—Montana Department of Natural Resources and Conservation, Water Resources Division. *Final Environmental Impact Statement for Water Reservation Applications in the Yellowstone River Basin*. Helena, Mont.: Department of Natural Resources and Conservation, 1975.

- **Increased Conflicts in the Upper Missouri River Basin:** Water rights in the Yellowstone River have never been judicially settled to determine how much water is actually available. Increased demands from Indian, energy, agricultural, and environmental interests have created considerable uncertainty over how remaining supplies will be used.

- **Damage to Environmental Resources:** As stream flows are increasingly depleted to meet the needs of industrial, agricultural, and municipal uses, damage could result, including loss of recreational uses, habitat damage from reduced flows and wetlands removal, and damage to scenic and aesthetic values.

Projections of Water Requirements and Availability in Colorado River - Year 2000



- **Conflicts with Indian Values:** Indian values and culture could be threatened depending on how issues such as Indians' reserved water rights are resolved. This could reduce overall energy development by impeding development of the extensive energy resources located on Indian land and would further complicate the legal and political problems.

- **Restriction or Elimination of Irrigated Agriculture:** If existing water resources are diverted for use in energy resource development, it will often be at the cost of agricultural lands. Since this could change the basic economic structure and threaten many western values, political conflicts would almost certainly increase between the federal and state governments, among regions, and among states in the West.

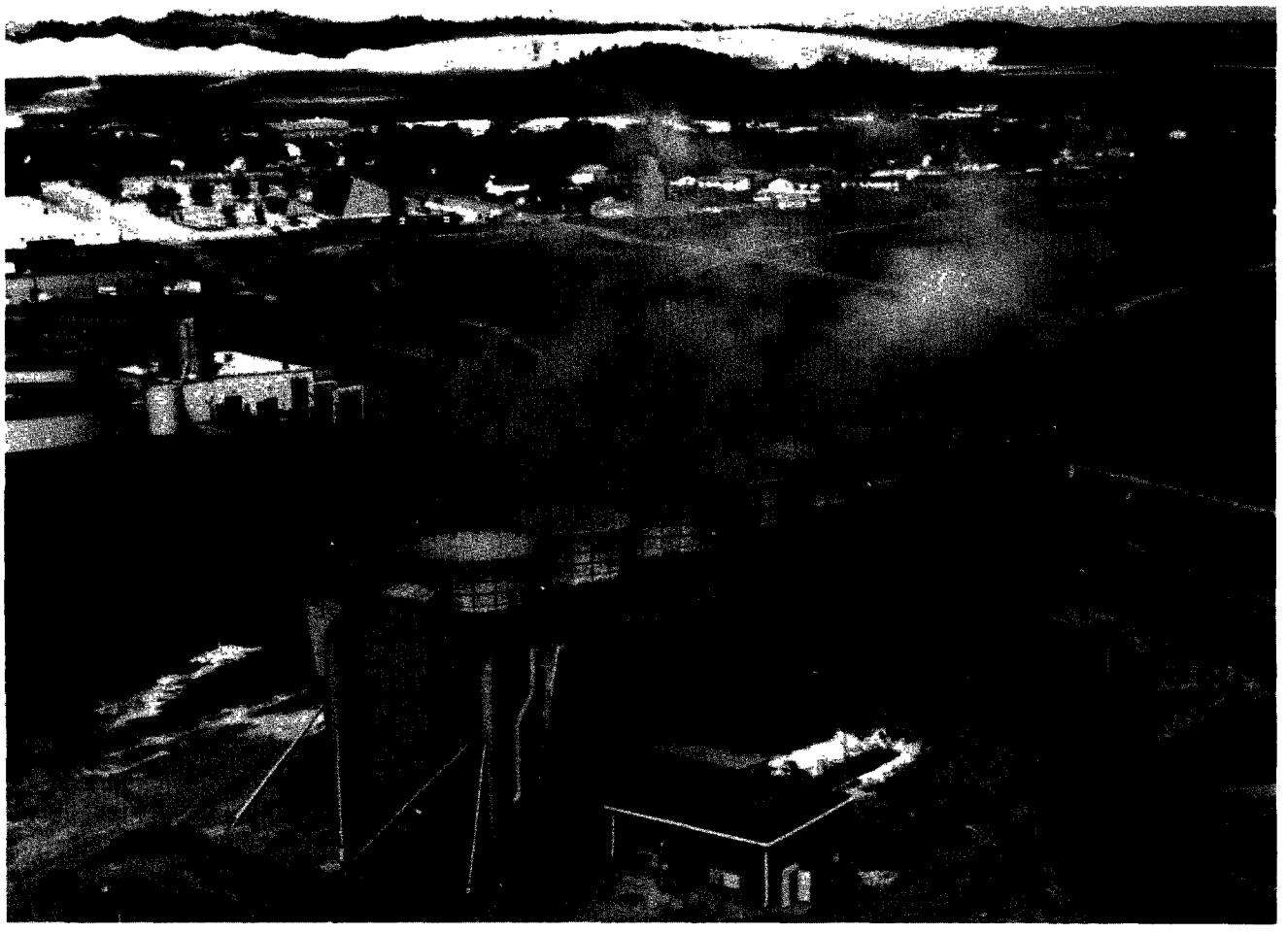
Policy Alternatives

If policymakers try to meet the expanded needs of water users, two general categories of policy alternatives can be considered: (1) increase water supply (augmentation); or (2) increase the use of existing supplies (conservation). Several specific alternatives exist in each of these general categories. Policymakers could take a very different approach by explicitly reducing or eliminating water-intensive uses in some areas, including energy development and irrigated agriculture. One of the most critical issues raised by these choices is where the political authority will rest. Our findings include the following:

- **Water Augmentation:** Several augmentation options can provide needed water supplies, particularly during the short term. Measured in terms of millions of acre-feet which can be added per year, the most effective choices appear to be interbasin transfers, groundwater mining, and weather modification. However, several disadvantages of these choices emerge:

Water Availability Alternatives

Category of Alternative	Specific Alternative
Increased water supply (augmentation)	• Surface diversion, transfer, and storage • Groundwater storage • Groundwater use • Weather modification • Vegetation management
Increased use of existing supply (conservation)	• Conservation for energy resource development • Conservation for agriculture • Conservation for municipalities



Wet Cooling Towers for Coal-Fired Power Plant

Interbasin and intrabasin transfers, groundwater mining, and groundwater storage will each cost in excess of $30 per acre-foot of water.

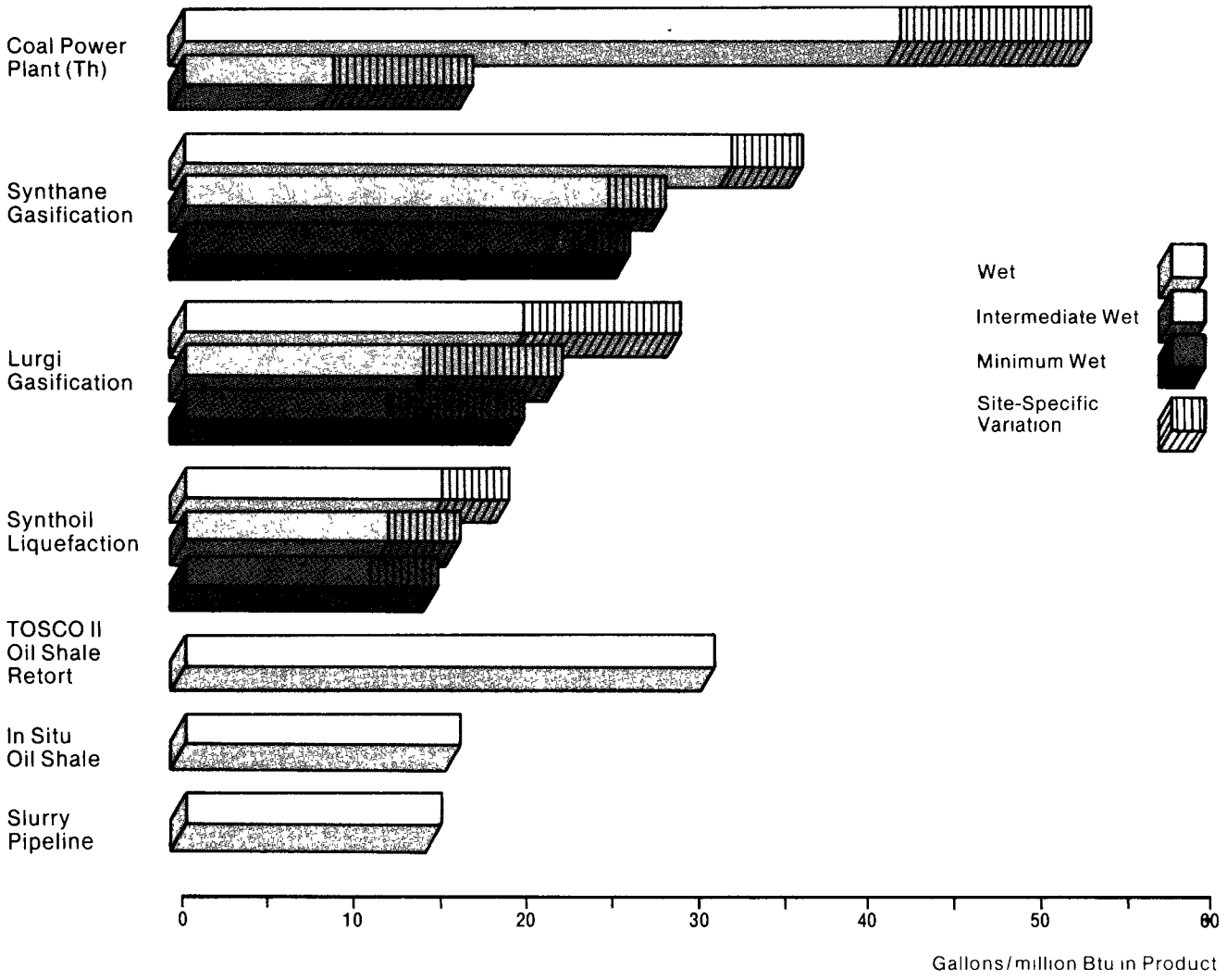
Vegetation management and phreatophyte removal present the greatest environmental risks of these alternatives, in the sense of damaging wetlands, wilderness areas, or scenic areas.

Most of these alternatives are inflexible, either because they are capital-intensive (e.g., water transfer, impoundments, groundwater storage) and therefore require long-term resource commitments, or because they can cause relatively irreversible or long-term impacts to streams and forest lands

States Rights Stressed

President Carter's proposal for comprehensive water policy reform has met stiff resistance in the western states. The National Governors' Association Subcommittee on Water Management has supported a comprehensive national water policy which addresses state water problems. However, the subcommittee concludes that such a policy must recognize ". . .the state's primary role in water management. . ." and that the policy must be flexible in response to the states.

—U.S., Congress, Senate, Committee on Environment and Public Works. *Water Research and Development. Hearings* Before the Subcommittee on Water Resources, 95th Cong., 2d sess., April 7, 1978, pp. 297-311.



Water Requirements for Energy Conversion Facilities

- **Water Conservation:** Although potential water-savings from irrigation and from municipal conservation are uncertain, savings from energy conservation can be significant. The most basic option in this regard is to avoid siting water-intensive conversion technologies in water-short areas.

If wet cooling is used, electric power generation will require more water than gasification, liquefaction, and oil shale development.

Among coal synthetic fuel technologies, Lurgi gasification requires from 25 to 45 percent more water than Synthoil liquefaction to produce an equivalent amount of energy

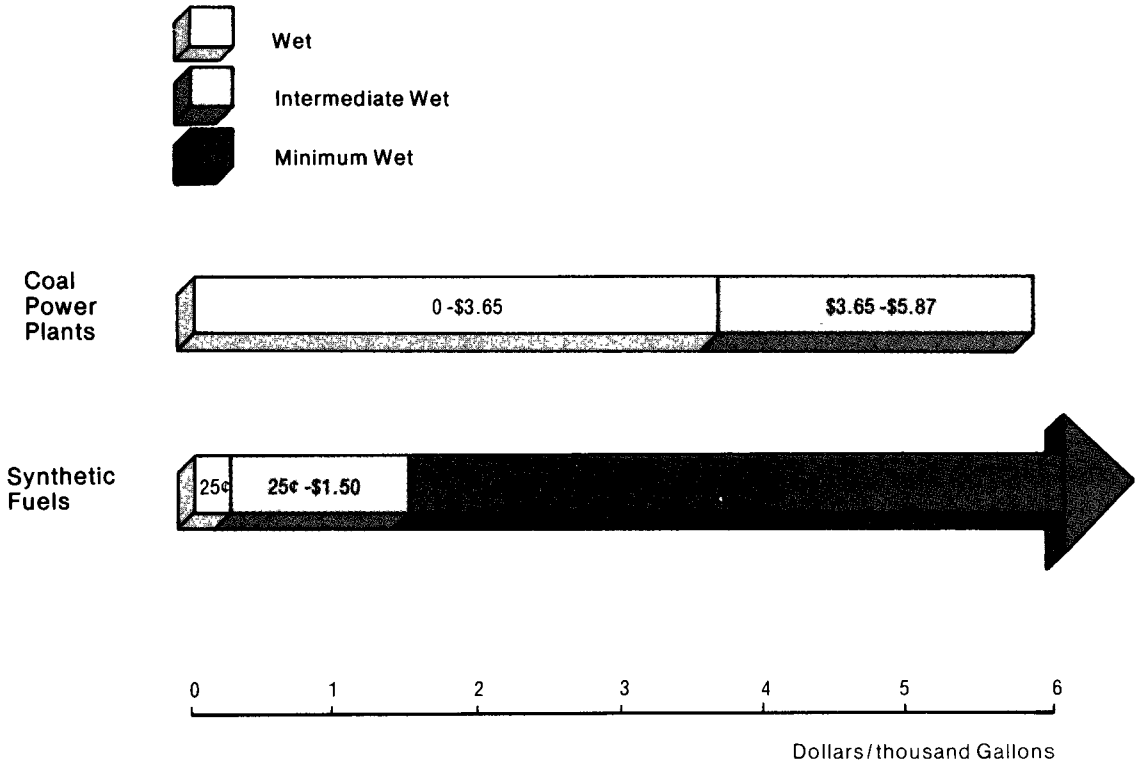
Water requirements for energy conversion facilities may also be reduced by using a combination of wet and dry cooling.

Intermediate wet cooling can reduce the total plant requirements by as much as 32 pecent for Lurgi gasification and 77 percent for electric power generation. This could save about 96,000 to 106,000 gallons per million British thermal units (Btu's) depending on where the plant would be located By using minimum wet cooling, as much as 42 percent of the water requirements of the Lurgi process could be saved.

For synthetic fuel facilities, intermediate wet cooling is economical if water costs more than 25 cents per 1,000 gallons ($81 per acre-foot) and minimum wet cooling is economical if water costs more than $1.50 per 1,000 gallons ($490 per acre-foot).

For power plants intermediate wet cooling does not become economical until water costs $3 65 to $5 87 per 1,000 gallons ($1,190 to 1,910 per acre-foot)

The economic cost of using water-saving cooling techniques is much lower for synthetic fuel facilities than for power plants For Lurgi, minimum wet cooling costs about 1.5 cents per million Btu's of gas, representing about 0.5 percent cost increase. However, for power plants, intermediate wet cooling would increase costs about 8 percent

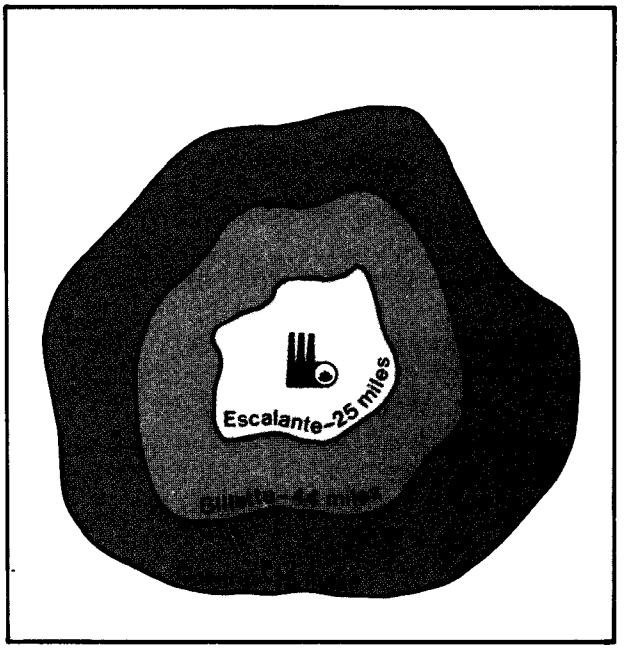


Breakeven Water Costs of Cooling Alternatives

Air Quality

Problems and Issues

Along with water availability, air quality issues have a major influence on western energy development. Conflicts between the goals of increasing energy development and protecting the West's generally pristine air will directly affect which resources are developed, the technologies used, and costs of the energy products. In addition to conflicts among goals and values, decisions about energy development are made more difficult by the complex, ambiguous, and constantly changing set of federal and state air quality regulations. These appear to be the most important air quality issues:



Separation Distance Between 3,000 MWe Power Plants and Class I Areas (80% SO_2 Removal)

PSD Reclassification Conflict

The Northern Cheyenne tribal chairman, Allen Rowland, has stated that "we are not requesting this redesignation because we are against progress. For us progress means developing our environmental resources in renewable and compatible manners such as timber and agricultural products. They are the cores of our value systems as people."

When the State of Wyoming objected to the redesignation citing possible restrictions on development in some parts of the state, Eric Metcalf, a Cheyenne spokesman, replied, "They're saying: 'We want to make decisions in our area, but you can't make those decisions for yours.' "

—"The Cheyenne Drive for Clean Air Rights." *Business Week*, April 4, 1977, p. 29.

- **Effects of Prevention of Significant Deterioration (PSD) Regulations:** Restricted resource development and continued conflicts over where development occurs are likely because of the large number of mandated and potential Class I PSD areas in the eight-state study area and because of the complexity and uncertainty of the PSD regulations. Calculation of estimated "buffer zones" required for large power plants to meet Class I sulfur dioxide (SO_2) increments in the six site-specific scenarios shows distances ranging from 14 to 75 miles.

- **Emissions Offset Policies:** EPA's emissions offset policy allows development in areas already violating National Ambient Air Quality Standards while PSD policies may constrain economic development in the West. Many westerners view these policies as discriminating against their region.

- **Ambient Air Impacts in Growth Communities:** Concentrations of pollution due to population increases associated with new energy facilities usually exceed those from the energy facilities themselves even though urban emissions are usually only about 10 percent of those produced by the energy facility. This occurs because population emissions, primarily from automobiles, are released close to the ground. Yet, state and local officials have very little control over emissions from mobile sources.

- **Background Pollution Levels:** Background levels of total suspended particulates, hydrocarbons, and oxidants (ozone), apparently from natural sources, have been measured near or above federal ambient standards in some areas of the West. Energy development could be restricted unless regulations take these naturally occurring conditions into account.

- **Effects on Visibility:** Visibility considerations have an uncertain, but potentially very significant, effect on western energy development. Visibility standards for Class I PSD areas are required under the 1977 Clean Air Act (CAA) Amendments; however, these have not yet been promulgated and scientific understanding of the relationship between emissions and visibility is incomplete.

Complexity of Air Quality Regulations

"The fatal weakness of our national energy/environmental policy is its failure to come to grips with the complexities of the required procedures through which decisions must come . . . .The PSD and nonattainment provisions taken in combination create major procedural obstacles. . . .I think we focus too much on the substance of whether the technology would make it possible to solve these problems and not enough on the process and procedure."

—Quarles, John. Comments at Sixth Government Affairs Seminar, Air Pollution Control Association, March 22-23, 1978.

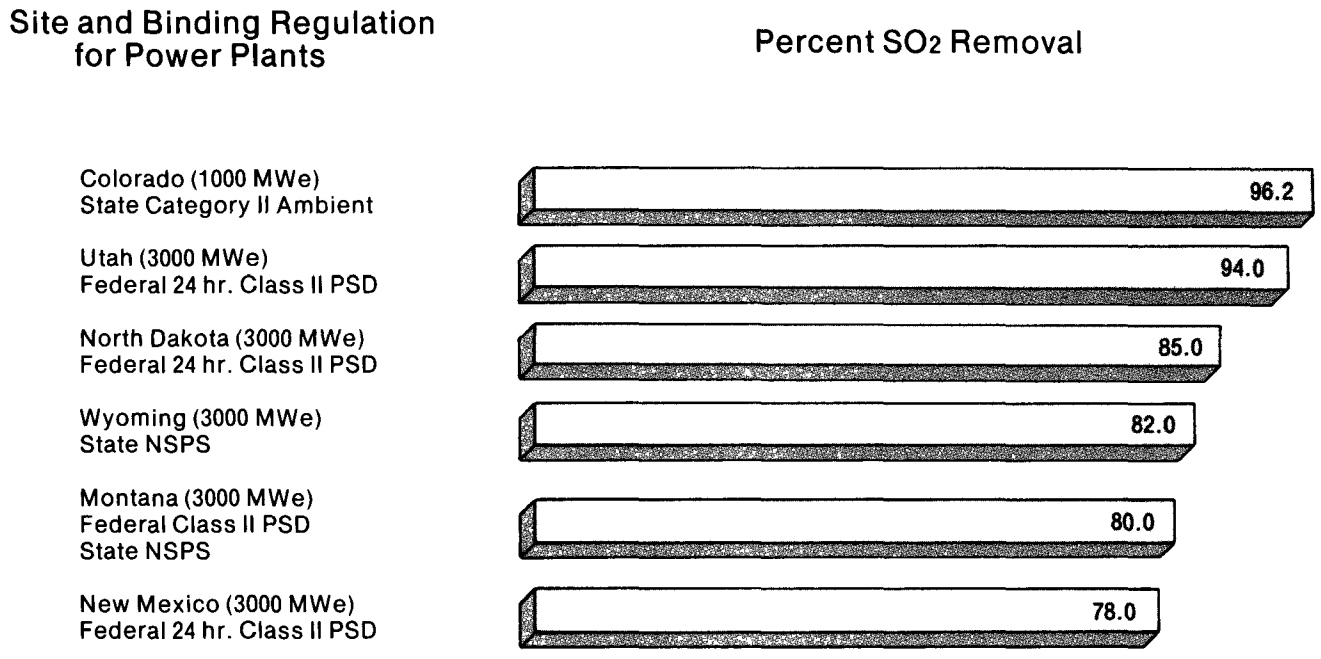
Policy Alternatives

Future air quality policies will need to reconcile the conflicts between energy and environmental values in the West. In this regard, three categories of policy alternatives have been identified: modify standards and regulations; alter technological and siting choices; and improve the procedural mechanisms for siting. Although a variety of specific policy alternatives are identified, four have been evaluated in this study.

Air Quality Alternatives

Category of Alternative	Specific Alternative
Modification of standards and regulations	• Definition of best available control technology (BACT) for SO_2 emissions as 90% removal
Alteration of technological and siting choices	• Construction of smaller, dispersed energy facilities • Increase of commercialization programs for less polluting technologies
Improved procedural mechanisms for siting	• Establishment of task forces for identifying future sites

SO_2 Removal Necessary to Meet all Standards Except BACT



- **Best Available Control Technology (BACT):** As required by the 1977 CAA Amendments, this policy alternative would regulate emissions for SO_2 by requiring a set percentage sulfur removal rate (for our analysis 90 percent was chosen), regardless of the original sulfur content of the coal. This contrasts with the previous New Source Performance Standards (NSPS) which set SO_2 emission limits at 1.2 pounds of SO_2 per million Btu's input.

SO_2 emissions from power plants are estimated to be about one-half as much by 1995 under this standard compared to a continuation of the previous NSPS.

However, even without BACT large power plants in the West will require strict SO_2 controls to meet other applicable standards; estimates range from 78 to 96 percent

Removing the advantages of utilizing low sulfur coal would cause Northern Great Plains coal production to grow much less rapidly. However, estimates are that 1990 production would still be 175 percent higher than 1975 levels.

The same emission levels could be achieved at lower costs by providing incentives for low sulfur control.

Monitoring costs will be higher in order to measure both sulfur removal percentages and emission rates.

Coal-Fired Power Plant in Four Corners Area of New Mexico

Smaller Power Plants

"It has been conventional system planning wisdom for a long time that construction of plants of ever-increasing capacity is desirable (1) to achieve scale economies, and (2) to reduce the environmental impact associated with siting a number of smaller generating plants. We believe these arguments must now be reexamined in light of current conditions and future prospects."

—New York Public Service Commission, Opinion No. 78-3, March 6, 1978.

- **Smaller, Dispersed Facilities:** Under this alternative, industry would, for example, build three 500 megawatt-electric (MWe) plants at dispersed sites instead of one 1,500 MWe plant.

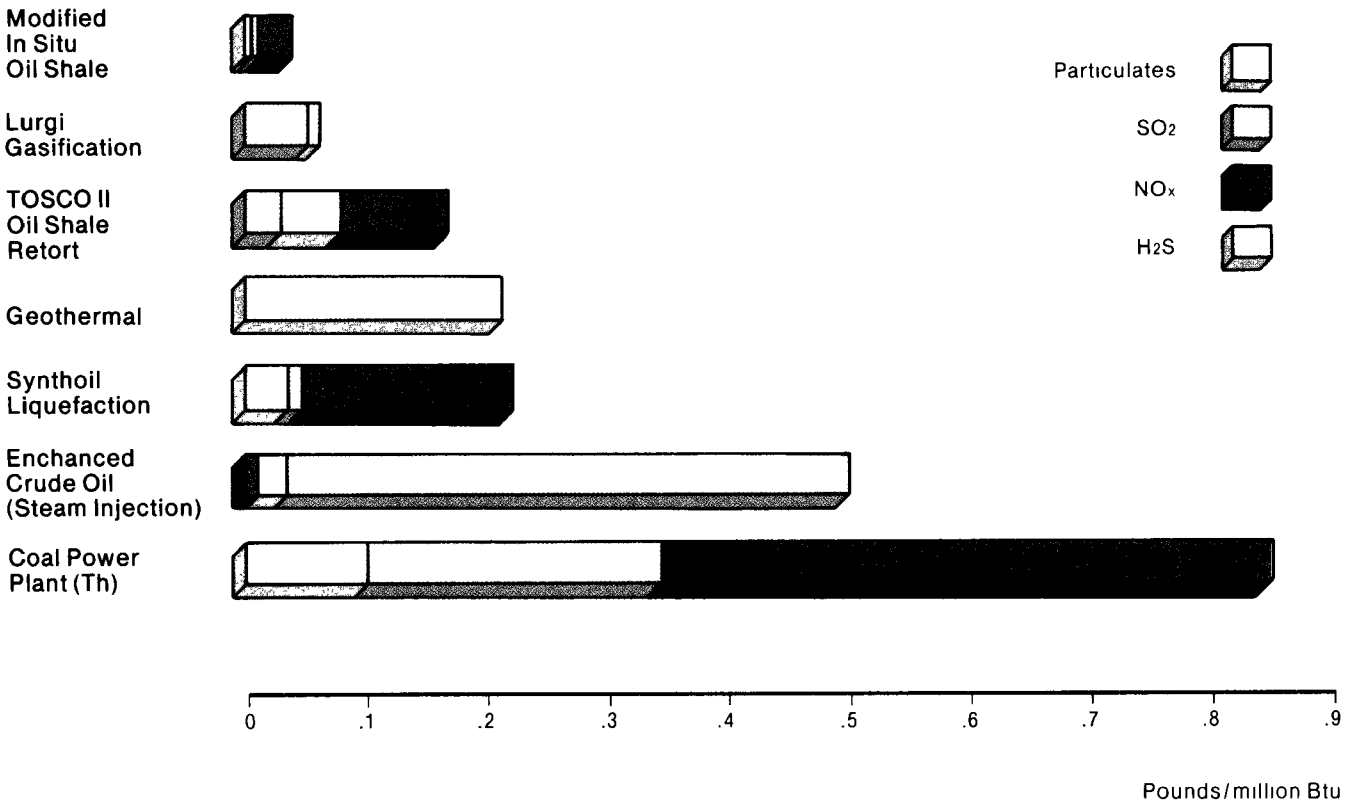
  While overall emissions would not necessarily be affected, pollutants would be dispersed over a wider area. Dispersion effects would be similar to using "tall stacks."

  Other negative impacts, such as water consumption and boomtown effects, would also be dispersed; another advantage would be that tax and other economic benefits for local governments would be more uniformly distributed.

  Land requirements may be two to three times larger; other costs are also likely to be higher depending on many site-specific factors.

  Although each plant should face less difficult siting requirements, this may be offset by the increased number of plants that would be sited.

Air Emissions on an Equivalent Energy Basis



- **Commercialization Programs for New Technologies:** Technologies such as coal gasification, *in situ* oil shale production, and geothermal power production would allow increased energy production with less impact on air quality than is created by power plants.

  Most of the new technologies examined produce considerably fewer air emissions per unit of energy produced than power plants

  Economic costs and risks for such a program would be large: commercial scale synthetic fuel plants can cost at least $0.5-1.0 billion.

  Implementation would be difficult, since risks are high and close cooperation would be required among federal agencies, western states, and industry

- **Siting Task Force:** The goal of a task force representing various parties-at-interest (e.g., state and federal agencies, environmental groups, farmers and ranchers, etc.) would be to agree on future energy facility sites (for example, in areas less environmentally sensitive) in order to reduce siting delays at the time the facilities are needed.

  This approach has been tried in Utah, apparently successfully.

  Economic costs for the task force would generally be small, unless extensive environmental studies are undertaken.

  Implementation should be straightforward; it could be convened at the request of the governor; no new institutions or laws would be required.

Clean Water Compromise Views Differ

Environmentalists have charged that the 1977 Clean Water Act will slow the pace of water pollution clean-up. A spokesman for the Clean Water Action project said the changes were a step backward. Especially troublesome to some environmentalists were delays in requiring industry to install pollution control equipment and permit exemptions for discharge of dredge or fill-in projects specifically authorized by Congress. Industry spokesmen, concerned over the cost of pollution control equipment, called the bill a reasonable compromise.

— *Denver Post*, November 12, 1977.

Water Quality

Problems and Issues

Water quality is closely related to water availability and will become an increasing concern as energy resources are developed in the eight-state study area. Energy resource development will require large quantities of unappropriated water, which in conjunction with increased demands from other water users, can degrade water quality by concentrating pollution. Water quality can be affected more directly as a consequence of solid and liquid wastes produced by energy facilities and wastewaters from municipalities, whose populations are likely to increase dramatically due to construction and operation of energy facilities. The most important water quality issues associated with energy development appear to be the following:

- **Pollution From Holding Ponds:** Effluents discharged to on-site evaporative holding ponds can pollute surface water and groundwater because of berm failure and/or seepage, and are a long-term waste disposal problem. Current federal and state regulations appear inadequate to deal with these potential problems.

- **Effects of Mining and *In Situ* Resource Recovery:** Mining and *in situ* oil shale or uranium recovery can disrupt and contaminate aquifers which can, depending on hydrological connections, then affect surface flow or other groundwater users.

- **Municipal Wastewater Treatment:** Inadequate treatment is already a problem in many areas, resulting in pollution of surface water and groundwater, community health problems, and restricted municipal growth. Few communities impacted by resource development will be able to afford the costs of upgrading capacities to meet new demands or installing secondary and tertiary treatment required by the Federal Water Pollution Control Act and Clean Water Act.

Waste Holding Ponds at Coal-Fired Power Plant

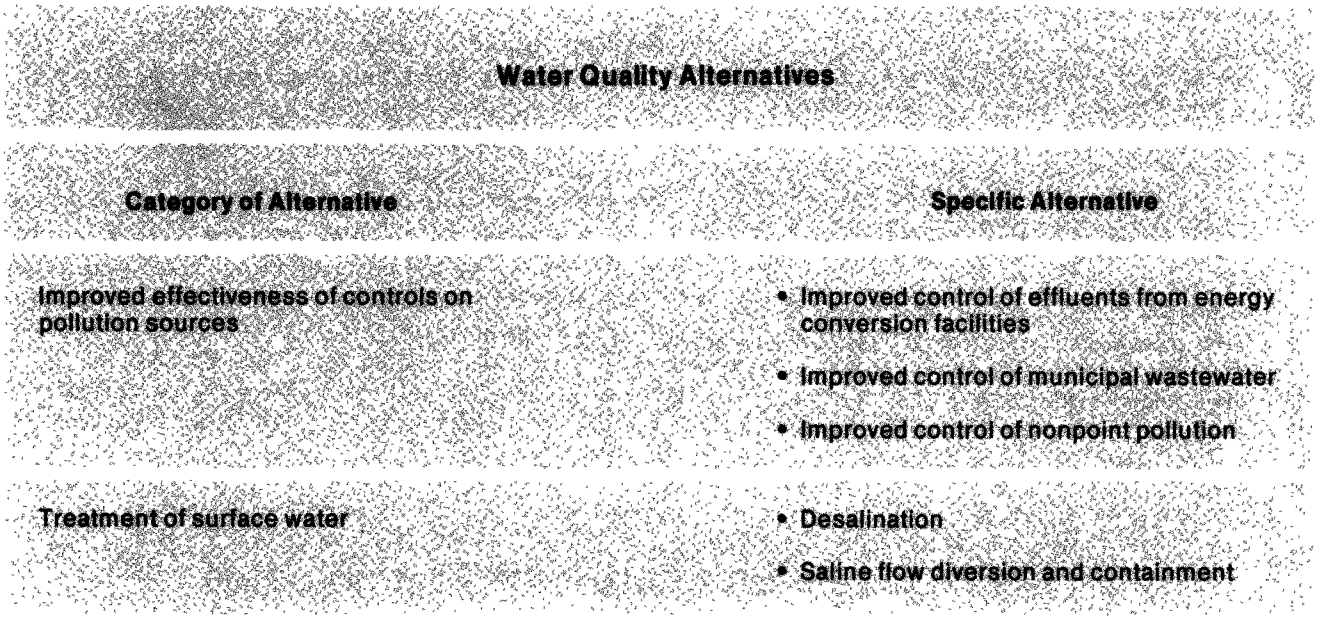
- **Control of Salinity:** Agricultural, environmental, industrial, and municipal damage is already caused by salinity. Salinity control problems, which will be increased by energy development, will continue to strain intergovernmental relations, particularly among states of the Colorado River Basin.

- **Economic Costs:** Prices for energy products will almost certainly increase because of the need for improved effluent control and holding pond design and maintenance. Costs of agricultural products may also increase because of the need to improve irrigation efficiencies to reduce runoff, particularly if reduction of irrigation runoff is used to offset salinity concentration due to energy development in a river basin.

Salinity Rights

The Environmental Defense Fund (EDF) has sued EPA to require stricter control of salinity in the Colorado River Basin. EDF has estimated the salinity cost for agricultural, municipal, and industrial users to be over $50 million annually. EDF supports the creation of salinity rights, similar to current water rights, in order to regulate the quality of water returned to surface waters.

—See Gill, Douglas. "Man, Nature Share Blame for Colorado River's Salinity." *Denver Post*, April 24, 1977; and "EDF to Sue for Water Salinity Control." *Denver Post*, April 15, 1977.



Policy Alternatives

Two general categories of policy responses are considered in order to deal with these problems and issues: improve the effectiveness of controls on pollution sources; and/or treat the pollution in surface water.

- **Pollution From Energy Facilities:** One strategy for dealing with water quality is to avoid those technologies which produce the most effluents.

  TOSCO II and modified in situ oil shale processes generate more effluents than any coal conversion technology studied

  Valued on a thermal basis, electric power generation produces fewer effluents than the three synthetic fuel processes studied.

Improved design, maintenance, and monitoring of holding ponds will also be necessary to control the inadvertent release of effluents produced by energy production facilities. Given current knowledge and experience, it is uncertain how effective this response would be.

It is certain that these ponds contain large quantities of effluents: over a 25-year period, about 1.5 million (Lurgi) to 3.5 million (Synthoil) tons of effluents (dry basis) per plant can accumulate in holding ponds.

These effluents contain heavy metals, trace elements, and other toxic pollutants, and appropriate designs and pond liners can considerably improve pond safety.

- **Salinity Control:** Desalination and reduction of runoff from irrigated agriculture are the most likely salinity control options.

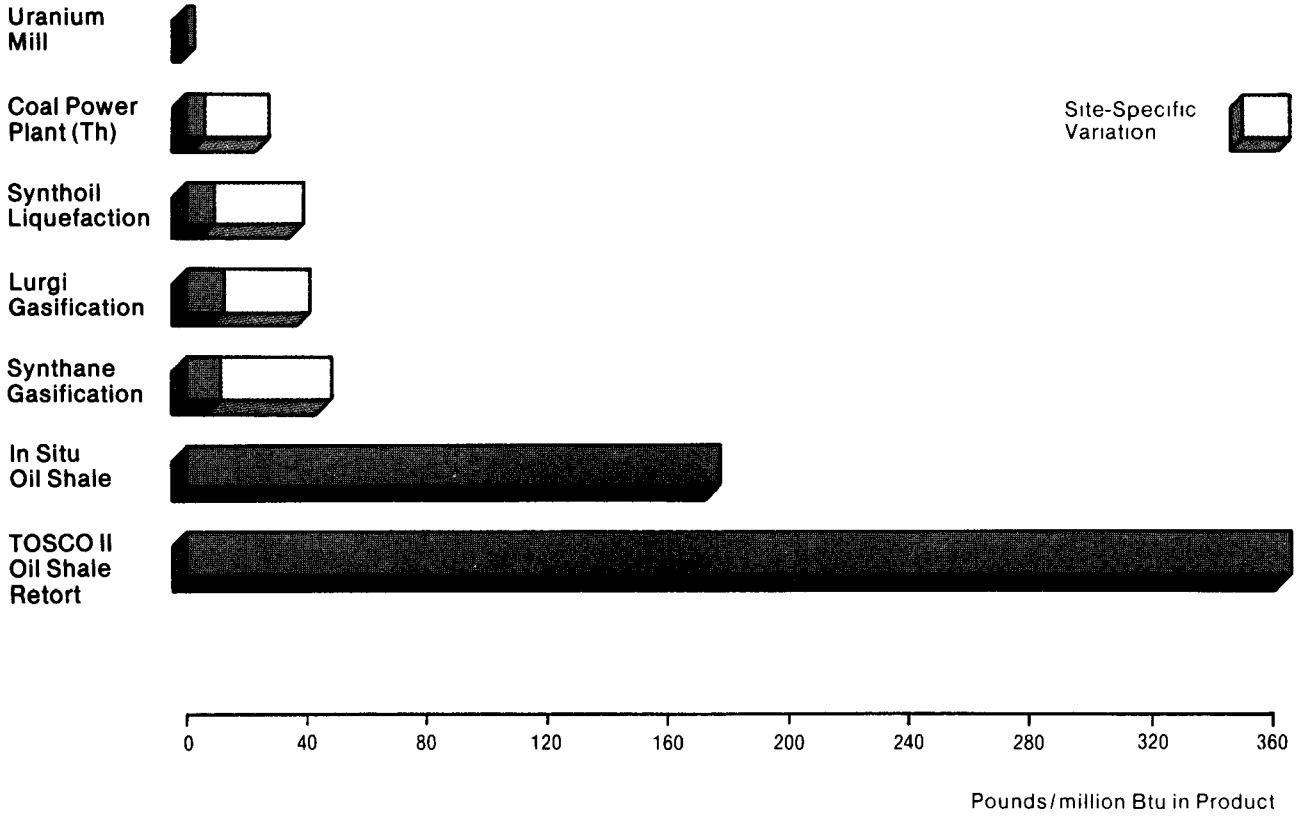
  Desalination could remove up to 600,000 tons of salt per year per plant on the Colorado River.

  Although desalination plants are very capital- and energy-intensive, they appear to be one of the most efficient options with respect to cost (less than $70 per ton of salt removed) and reliability.

  Lining distribution canals and producing water efficient crops also cost less than $70 per ton of salt. However, improved irrigation efficiency costs about four times this much.

- **Implementation Costs:** Several water quality control alternatives will be difficult to enact and implement because of the large capital investments required. This is particularly so for municipal waste treatment, desalination, stream flow diversion, and irrigation efficiency improvements. Each of these alternatives can contribute to increased public expenditures, require long-term commitments, and may not be broadly applicable across the western states or to the specific water quality problems associated with individual energy facilities.

Solid and Liquid Effluents from Technologies



- **Revenue and Public Expenditure Imbalances:** Counties and school districts can anticipate rapid and large tax revenue increases because energy facilities typically are located within their boundaries. Towns will often suffer the most serious growth impacts but will receive little additional revenue in the short term.

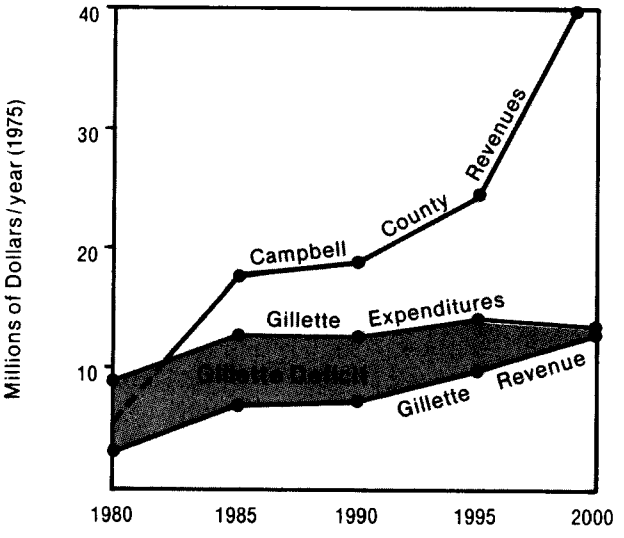
- **Inadequate Public/Private Sector Cooperation:** Current practice, reinforced by requirements of the National Environmental Policy Act, is to deal with impacts of each company separately, rather than with overall population impacts affecting energy company employees, long-time residents, and service workers alike. Planning and growth management difficulties are increased by inadequate information about timing, magnitude, and location of energy development activity.

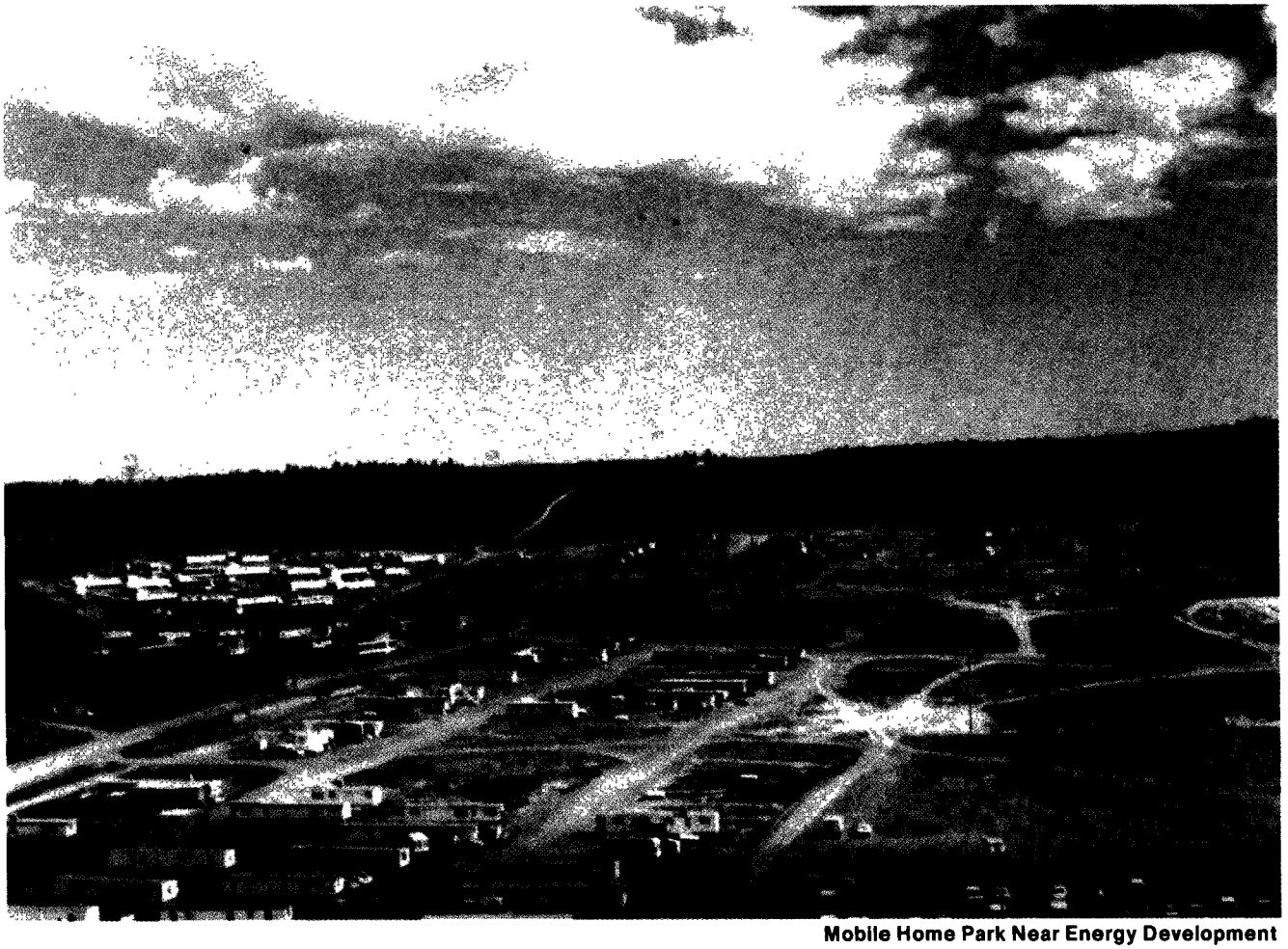
Growth Management and Housing

Problems and Issues

Energy resource development in the West can produce serious growth management and housing problems for small, isolated communities which often experience rapid and large population increases and boom-and-bust cycles. The most serious population changes will result from labor-intensive facilities such as coal gasification and electric power plants. Population increases from these developments will require rapid increases in expenditures for new public facilities and social services, housing, and higher quality mobile home parks. These appear to be the most serious growth management and housing problems:

Projected Revenue Imbalances in Campbell County, Wyoming - Year 2000





Mobile Home Park Near Energy Development

- **Public Sector Assistance:** Few federal programs are directed towards the problems of energy-impacted, rapid-growth situations, and those that are typically give funds to energy-rich county governments rather than to towns. Although several western states have established housing finance agencies, they have had little impact on housing markets.

- **Development Risks:** The risks of housing construction in energy development areas are apparently too great for lenders, developers, and energy firms. Relatively small western housing markets cannot compete with major urban lenders and are often unable to finance construction and mortgages. Thus, most newcomers live in mobile homes, which are often crowded, unmaintained, and contribute relatively little to local tax rolls.

Wright, Wyoming

"During the Sweetwater County, Wyoming, boom's early stages, the housing stock of the county was nearly doubled with 6,000 new units. Fifty-five hundred of these were mobile homes. . . .The housing market demand drove prices and rents up, yet investors and developers were skeptical of putting money into boomtown housing. Even if they had been willing, mortgage money was not available for the typical miner wishing to buy a home."

—Gilmore, John S. Transcript of Hearings Before the Subcommittee on Regional and Community Development of the Senate Committee on Environment and Public Works, 95th Congress, August 2, 1977, pp. 266-67.

Policy Alternatives

To deal with these issues, four categories of alternatives have been considered: tax structure changes, impact assistance, reductions in the number of workers living on-site, and increased housing construction.

- **Tax Structure Changes:** Several alternatives exist for changing the tax structure in order to provide revenue during the construction phase when large population increases first occur.

Several of these alternatives, particularly redistribution of state severance taxes and prepayment of property and sales taxes, appear to be effective means for dealing with growth management problems.

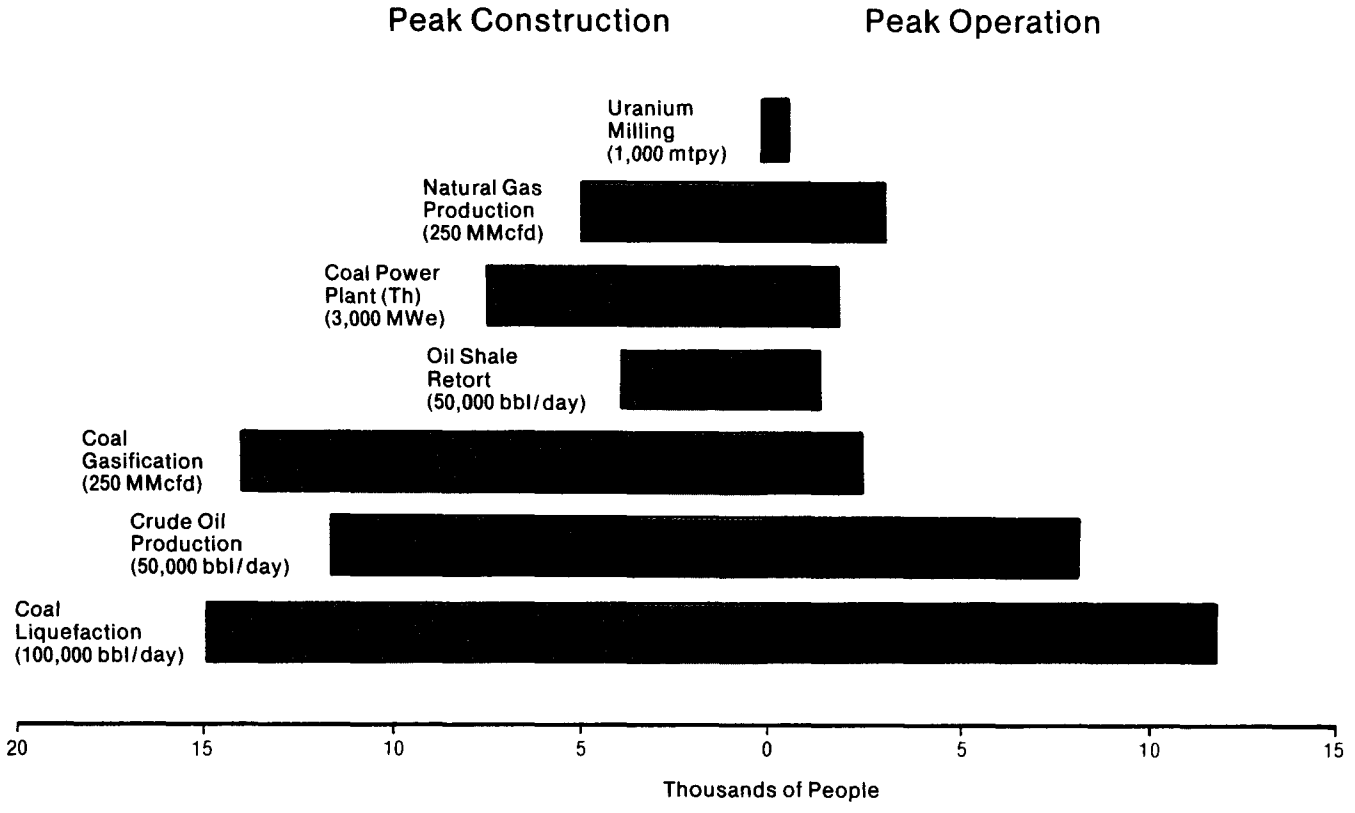
Tax structure changes appear equitable, since the direct beneficiaries of energy development would also share the costs, and they can be easily adjusted to specific situations and combined with other alternatives.

Tax structure changes will also create political problems, because state and county governments view the loss of control over revenue sources as a reduction in their authority and in their flexibility to address energy impacts.

Growth Management and Housing Alternatives

Category of Alternative	Specific Alternative
Tax structure changes	• Municipal annexation of county land • Prepayment of property and sales tax • State collection and distribution of property taxes • Severance taxes • Tax credits for private sector assistance
Impact assistance for rapid growth areas	• Water and sewer facility programs • Federal land and mineral payments
Reductions in workers living on-site	• Project schedule adjustments • Long distance commuting • Selective siting
Increased housing construction	• Housing requirements in siting permits • Industry investment

Population Increases from Energy Facilities



- **Energy Impact Assistance:** Federal impact assistance will probably be required to supply the necessary financial assistance to municipalities, particularly for water and sewer facilities.

  Impact assistance programs appear to be easier to administer in the critical near-term than state and local-level tax changes, but they would be costly and would not necessarily change the fundamental imbalance between town and county governments.

  State and local officials are also likely to perceive this choice as decreasing their control over revenue sources.

- **Selective Siting:**

  Consideration of siting choices to match technologies and locations could avoid many growth management and housing problems, if the most labor-intensive facilities are prohibited in areas least capable of handling population increases. Coal gasification and liquefaction facilities have the largest peak population increases during construction.

- **Industry Investment in Housing:**

  The cost of housing construction programs for industry can range from $5,000 per unit for site development alone, to more than $30,000 per unit for house construction (1975 dollars). Many energy industries appear unwilling to assume the risk of buying homes, since development plans could be delayed or cancelled.

  Improving the quality of mobile home parks, for example, by providing amenities typical of residential areas would be a flexible way to deal with the particular housing problems of each community.

known about the long-term success of reclamation in the West, but success will be related to climate, soil composition, topography, and existing biological communities. Reclamation appears to be most difficult in the arid Southwest.

- **Ecological Damage:** Land use to meet the needs of energy-related population growth generally produces more serious ecological impacts than land used directly by energy facilities. Public lands (national parks, forests, recreation and wilderness areas), particularly those in a natural state, are likely to experience the greatest changes as a result of population growth.

- **Conflicts Over Land Use:** Energy development will compete with other economically productive land uses, such as grazing and row crops, and with preservation, conservation, and leisure time uses. Conflicts are likely to increase among a variety of constituents and among government agencies as to how increased demands on land use should be accommodated.

Land Use

Problems and Issues

Energy development will disturb lands used for mines, access roads, support and conversion facilities, waste disposal, housing and recreation. Although these land uses will affect only a very small percentage of land in the region, they will intensify conflicts among energy developers, farmers, ranchers, environmentalists, recreationists, and others. The most important land-use issues appear to be the following:

- **Land Disturbance:** Most of the energy resources in the West will be extracted by surface mining, which disrupts large areas and produces more visible land degradation than underground mining. Relatively little is

New Recreation Demands

Grand Teton National Park is located 100 miles north of energy boomtown Rock Springs, Wyoming. Residents combined with out-of-state tourists resulted in three million visitors to the park in 1976. "Wyoming is feeling the effects of energy development," says State Senator John Turner. "It's doubled the population in some communities, brought in a rough crowd, caused an increase in mental health problems, divorce, alcoholism, and crime." Due to these increases 70 percent of the respondents in a public survey of residents of Jackson Hole (in the park) favored strong land-use controls and very limited growth.

–Leydet, Francois. "Jackson Hole: Good-Bye to the Old Days." *National Geographic*, Vol. 150 (December 1976), p. 771.

Piceance Creek Oil Shale Area in Western Colorado

Policy Alternatives

Two broad categories and four specific alternatives for dealing with land-use issues were identified. Of these, the two policy responses of reclamation and redevelopment have been evaluated. Reclamation refers to returning mined lands to the state that existed prior to development; with redevelopment, lands may be returned to some other productive use such as residential subdivisions, new towns, industrial parks, wildlife refuges, public parks, or waste disposal sites. The focus of our evaluation was on redevelopment to public parks.

Redevelopment to create recreation areas has a higher potential for success, especially in arid and semiarid areas. Generally, redevelopment can return lands to a productive use three to four years earlier than reclamation.

Costs for reclamation and redevelopment are about the same, ranging from $1,000 to $7,000 per acre (1977 dollars)

Redevelopment is generally more adaptable to site-specific conditions and gives local authorities more discretion in interpreting local needs.

The established need for expanded recreational opportunities for energy-related population increases challenges the appropriateness of a policy emphasizing only reclamation

Current land rehabilitation requirements are inadequate for lands disturbed by oil shale and uranium development.

Land Use Alternatives

Category of Alternative	Specific Alternative
Controlled land use	• Designation of permissible uses • Controlled access to and activities on public and private lands
Required rehabilitation of all lands disturbed by energy development	• Reclamation (return to predevelopment use) • Redevelopment to recreation areas (e.g., parks)

Other Issues

Problems and Issues

Our technology assessment considered three other categories of issues important to western energy resource development:

Capital availability

Energy facility siting

Transportation

Among the more important problems and issues in these categories are the following:

- **Economic Risks:** Considerable technical and regulatory uncertainty surrounds the commercial scale performance of technologies for producing energy from geothermal, oil shale, and coal gasification and liquefaction. Risks are great since synthetic fuel technologies can require investments of over $1 billion per facility, which is equivalent to almost the entire fixed investment of many large energy firms.

- **Competition:** Major oil and gas companies are acquiring large holdings of coal, oil shale, and uranium reserves in the West—about 40 percent of the nation's privately held coal reserves. Such acquisitions could close off competition among energy resources. Competition is also influenced by federal leasing policy, since almost 80 percent of western energy reserves are federally owned or lie under or adjacent to federal lands.

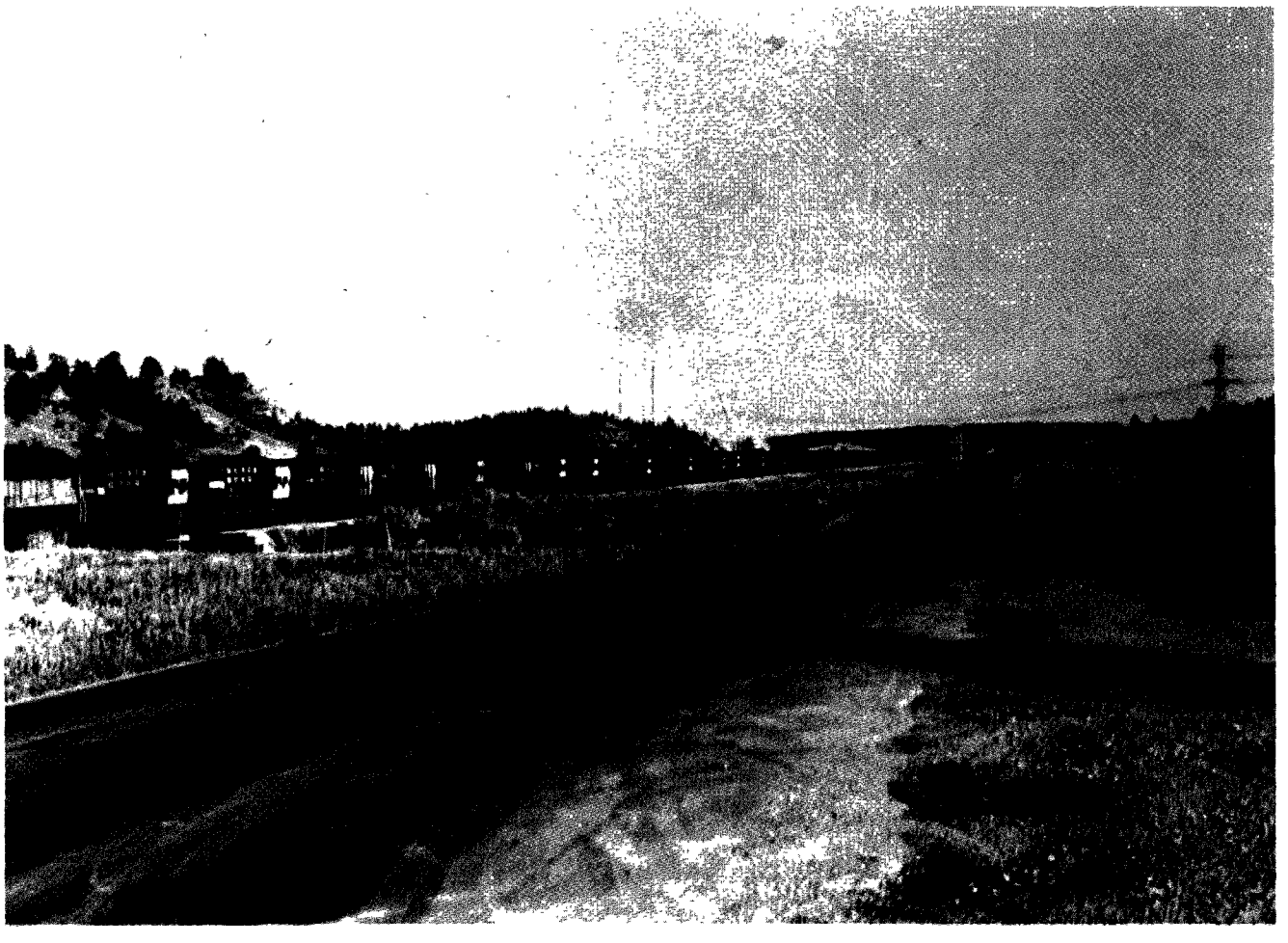
- **Regulatory Complexity:** Federal and state environmental policies restrict where development can occur, help to define how facilities will be configured, and require lengthy and uncertain review processes. These processes have become more complicated as diverse interest groups have gained better access to public decisions on energy development. Because siting decisions have seldom successfully balanced the interests at stake, many groups resort to a variety of tactics to delay or cancel projects.

- **Siting Uncertainties:** The conflicts that often occur over siting create such uncertainty that it has become virtually impossible to anticipate when, where, and at what level development will occur. These uncertainties contribute to the inability of local and state governments to manage development impacts and growth.

- **Inadequate Transportation Capacity:** Increased energy development in the West will require major expansion of transportation capacity. Based upon our low demand scenario, capital requirements by the year 2000 for coal slurries, unit trains, and electric transmission will exceed $26 billion (1975 dollars). Land requirements for these three transportation modes are projected to exceed 450 thousand acres.

- **Impacts of Train Traffic and Electric Power Transmission:** Heavy coal train traffic will create noise problems, bottlenecks at crossings, and health and safety problems. High voltage transmission lines create aesthetic impacts, the potential for electric shock, communication interference, and possible biological effects on people and livestock.

Unit Train Near Colstrip, Montana



Policy Alternatives

Several alternatives for dealing with these capital availability, facility siting, and transportation issues have been considered. Major findings from the evaluation of these alternatives are as follows:

- **Financial Subsidies:** Developers would be provided at least some increased stability by financial subsidies and they may be a necessity if certain of the newer technologies are to contribute to increased domestic energy production.

Capital, Siting, and Transportation Alternatives

Category of Alternative	Specific Alternative
Provision of financial subsidies to developers	• Tax preference • Price guarantees
Promotion of new sources of investment	• Consumer risk assumption • Improved leasing system
Improvement of the siting process	• Technology-site evaluations • Increased impact assistance • Improved mechanisms for citizen involvement
Enhancement of coal transport capacity	• Increased regulatory flexibility for railroads • Promotion of coal slurries
Mitigation of transportation impacts	• Improved safety and noise reduction of unit trains • Regulation of voltage and improved planning for transmission line routes

Price guarantees would primarily benefit larger companies since they would not reduce capital requirements.

Tax preferences, especially investment tax credits, would reduce capital exposure risks by allowing the developer to recapture part of the capital investment almost immediately.

These alternatives could require large public expenditures, but both price guarantees and tax preferences are well-established approaches to economic policy

- **Improvement of the Siting Process:** The success of technology-site evaluations, as well as most other siting alternatives, depends on fundamental changes in the system.

  Technology-site evaluations could improve the information base and reduce development risks by eliminating the most problematic sites.

  An important need is for equitable access to decisionmaking by parties-at-interest in combination with limits on how long and in what manner siting decisions can continue to be contested after review processes are over.

  "Reasonable" determination of where to locate energy development facilities eventually depends on the willingness of parties-at-interest to recognize the legitimacy of other values. Otherwise, the result will be a continuation of the uncertainties, inequities, and at times, paralysis of the existing system

- **Mitigation of Unit Train Impacts:** Improving safety signals at crossings or constructing grade separations or by-pass lines around towns can reduce coal train impacts.

Concerns of Increased Coal Train Traffic

Mayor Hammond of Lusk, Wyoming, summed up the worries of his constituency: "We get one freight a day through here now and that ties up traffic coming in and out of town. What do we do if there's a fire, or if someone has a heart attack on the other side of the track when these unit trains start running? We just don't know what's going to happen."

—Richards, Bill. "Paying the Price for Western Energy." *Washington Post*, December 13, 1976.

Little can be done to reduce noise impacts except to build new tracks away from as many people as possible.

Grade separations and track rerouting are costly, the former ranging between $750,000 and $1.5 million (depending on conditions), and the latter expected to cost $500,000 per mile for new double tracks.

- **Enhanced Coal Transport Capacity:** The most attractive approach to increasing coal transport capacity would appear to include both coal slurry and rail transport.

  Slurry pipelines are sometimes cheaper than rail transport, especially in high volume, long distance applications

  Slurries are relatively inflexible in terms of shipping capacity; they must be operated at a more or less constant volume of flow and at a very high capacity between a fixed supply point and fixed demand points

  Thus, under no circumstances would slurry pipelines totally substitute for rail transport.

  With a combined slurry pipeline-railroad system, there will be less of a threat to coal supply disruption due to accidents, strikes, or weather

Current Work

The Science and Public Policy Program of the University of Oklahoma is currently extending the analysis of water availability and water quality problems related to western energy development. This work, scheduled to be completed by December 1979, builds on our previous analysis of likely water impacts, problems, and issues. A range of water policy alternatives is being analyzed, including:

- *Water management strategies*
- *Water pricing strategies*
- *Conjunctive use of groundwater*
- *Quantification of Indian rights*
- *Conservation in energy conversion facilities*
- *Conservation in agriculture*
- *Salinity control options*
- *Use of saline water in energy facilities*
- *Policies governing waste disposal*
- *Control of groundwater contamination from mining*

These alternatives and others will be evaluated and compared to improve our understanding of the water issues associated with western energy resource development.

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Impact Analysis Report, 1979
- Vol. I: *Introduction and Summary* (EPA-600/7-79-082a)
- Vol. II: *Site-Specific and Regional Impact Analysis* (EPA-600/7-79-082b)

Energy Resource Development Systems Report, 1979
- Vol. I: *Introduction and General Social Controls* (EPA-600/7-79-060a)
- Vol. II: *Coal* (EPA-600/7-79-060b)
- Vol. III: *Oil Shale* (EPA-600/7-79-060c)
- Vol. IV: *Uranium* (EPA-600/7-79-060d)
- Vol. V: *Oil and Natural Gas* (EPA-600/7-79-060e)
- Vol. VI: *Geothermal* (EPA-600/7-79-060f)

Work Plan for Completing a Technology Assessment of Western Energy Resource Development, 1978 (EPA-600/7-78-012)

A Progress Report of a Technology Assessment of Western Energy Resource Development, 1977
Executive Summary (EPA-600/9-77-032)
- Vol. I: *Summary* (EPA-600/7-77-072a)
- Vol. II: *Detailed Analyses and Supporting Materials* (EPA-600/7-77-072b)
- Vol. III: *Preliminary Policy Analysis* (EPA-600/7-77-072c)
- Vol. IV: *Appendices* (EPA-600/7-77-072d)

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Gold, Harris, and D. J. Goldstein. *Wet/Dry Cooling and Cooling Tower Blowdown Disposal in Synthetic Fuel and Steam-Electric Power Plants*. Washington, D.C.: U.S., Environmental Protection Agency, 1979 (EPA-600/7-79-085)

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