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Energy from the West: A Progress Report

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THE ENERGY/ENVIRONMENT R&D DECISION SERIES

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Energy from the West

A Progress Report of a
Technology Assessment of
Western Energy Resource Development

Executive Summary

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FOREWORD

The production of electricity and fossil fuels inevitably creates adverse impacts on Man and his environment. The nature of these impacts must be thoroughly understood if balanced judgements 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 the information on health and ecological effects - and methods for mitigating the adverse effects - that is critical to developing the Nation's environmental and energy policy. OEMI's Integrated Assessment Program combines the results of research projects within the Energy/Environment Program with research on the socioeconomic and political/institutional aspects of energy development, and conducts policy - oriented studies to identify the tradeoffs among alternative energy technologies, development patterns, and impact mitigation measures.

The Integrated Assessment Program has utilized the methodology of Technology Assessment (TA) in fulfilling its mission. The Program is currently sponsoring a number of TA's which explore the impact of future energy development on both a nationwide and a regional scale. For instance, the Program is conducting national assessments of future development of the electric utility industry and of advanced coal technologies (such as fluidized bed combustion). Also, the Program is conducting assessments concerned with multiple-resource development in three "energy resource areas":

- Western coal states
- Lower Ohio River Basin
- Appalachia

This report describes the results of the first phase of the Western assessment. This phase assessed the impacts associated with three levels of energy development in the West. The concluding phase of the assessment will attempt to identify and evaluate ways of mitigating the adverse impacts and enhancing the benefits of future development.

The report is divided into an executive summary and four volumes:

- I Summary Report
- II Detailed Analyses and Supporting Materials
- III Preliminary Policy Analysis
- IV Appendices

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ENERGY FROM THE WEST: A PROGRESS REPORT OF A TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT

EXECUTIVE SUMMARY

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 consequences, the Office of Energy, Minerals, and Industry in the Environmental Protection Agency's Office of Research and Development initiated this 3-year "Technology Assessment of Western Energy Resource Development" in July 1975.

Energy Resources in Eight Western States

Resources	Reserves (Q's)	Percent of U.S. Total
Coal	4,000	37
Oil	14	7
Natural Gas	22	8
Oil Shale	2,340	90
Uranium	170	90
Geothermal	10	10

One Q $\simeq$180 million bbls of oil, or 80 million tons of coal, or 1 trillion cubic feet of natural gas.

PURPOSE

The overall purpose of this technology assessment is to attempt to determine what the consequences of energy resource development will be and what can be done about them. Although 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.

SCOPE

Geographically, the study includes eight Northern Great Plains and Rocky Mountain states: Arizona, New Mexico, Utah, Colorado, Wyoming, Montana, and North and South Dakota. The development of six energy resources within this eight-state area is assessed: coal, crude oil, geothermal, natural gas, oil shale, and uranium. The time period covered by the study extends to the year 2000.

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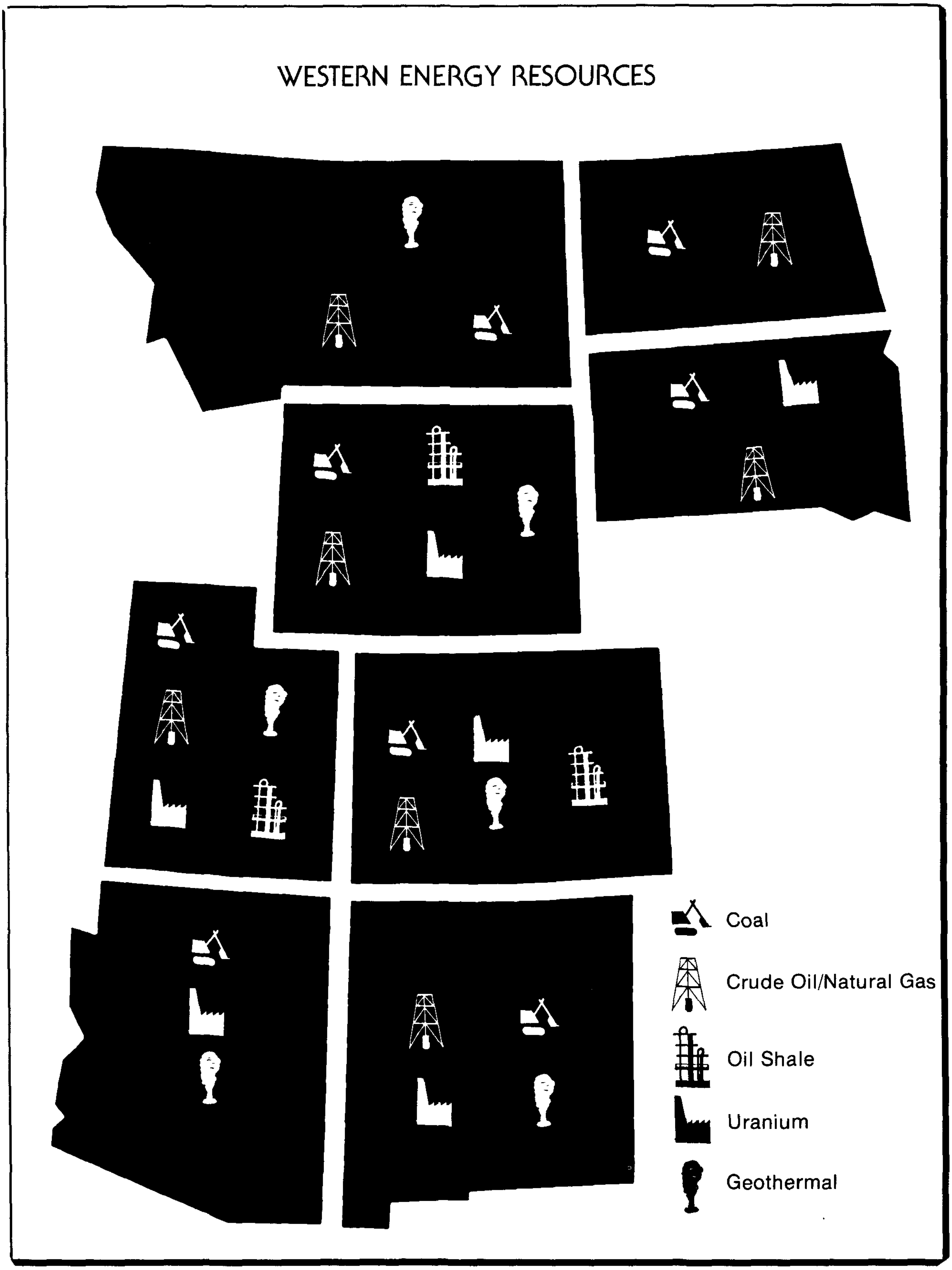
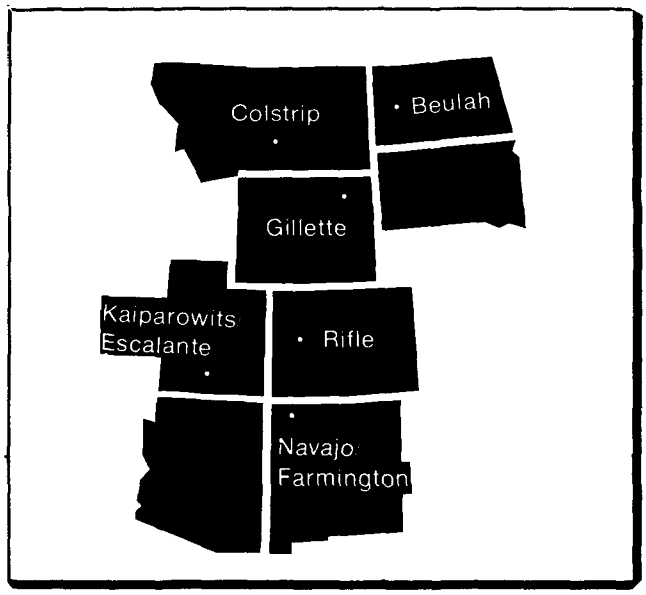

WESTERN ENERGY RESOURCES
Coal
Crude Oil/Natural Gas
Oil Shale
Uranium
Geothermal

SCENARIOS

Energy development within the entire eight-state area and at six sites are analyzed. Each of the six site-specific scenarios combines representative local conditions (such as topography, meteorology, population, and community services and facilities) and energy development technologies.



The technological alternatives assessed include surface and underground mining, conversion and export of coal, surface retorting of oil shale, milling of uranium ore, and conventional crude oil and natural gas production. Transportation by rail, pipeline, and extra-high voltage transmission lines are also examined.

Development Alternatives

Coal:
- Surface and Underground Mining
- Direct export by unit train and slurry pipeline
- Electric Power Generation
- Gasification
- Liquefaction
- Transportation by pipeline and EHV

Oil Shale:
- Underground Mining
- Surface Retorting
- Transportation by pipeline

Uranium:
- Surface mining
- Milling
- Transportation by train

Oil and Natural Gas:
- Conventional Drilling and Production
- Transportation by pipeline

Geothermal:
- Not assessed during the first year

The three levels of development for the eight-state study area that are assessed in the study are shown at the right. Approximately 7 Q's are currently being produced in this area.

LEVELS OF 8-STATE DEVELOPMENT (Q's)

Case	1980	1990	2000
Nominal	13.5	30.6	56.8
Low Demand	12.2	23.3	48.0
Low Nuclear Availability	11.1	22.5	49.8

FINDINGS

The principal objective during the first phase of the study has been to identify and analyze site-specific and regional impacts likely to occur when western energy resources are developed. The categories of impacts analyzed are listed at the right. In analyzing impacts in each of these categories, technological and locational factors were identified that can cause impacts to vary significantly depending on which technologies are sited at which locations.

The sections that follow summarize selected findings and some of their policy implications.

Impact Analysis Categories

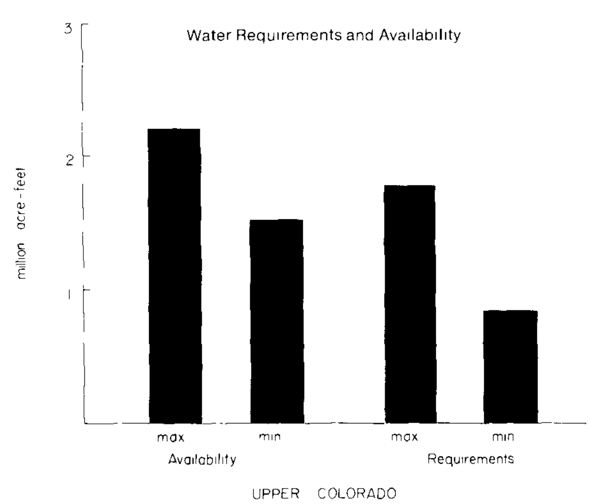
Site-Specific and Regional:	Air Quality Water Availability and Quality Social, Economic, and Political Ecological
Regional only:	Health Effects Transportation Noise Aesthetics

Water Quality and Availability

Water impacts can vary significantly because of a technology's water and labor requirements, the availability and quality of water, the characteristics of the energy resource, the location of underground aquifers, and the method used for effluent disposal. Water and labor intensive technologies will intensify water impacts; however, water requirements for energy-related population increases are small compared to process and cooling requirements. Conflicts among water users and water quality impacts will generally be more severe in arid areas. Some technological alternatives utilize the moisture content of the energy resource being converted thereby decreasing process water requirements; however, high moisture content also reduces process efficiency. Water quality impacts will be more severe when the energy resource has a low-Btu, a high sulfur, toxic materials, and trace elements content; is located in an alluvial valley; and is an aquifer.

The following are among the findings produced by the impact analyses conducted during the first phase of the study.

- Large-scale energy development could result in water shortages and conflicts among users in some western states, particularly within the Upper Colorado River Basin.



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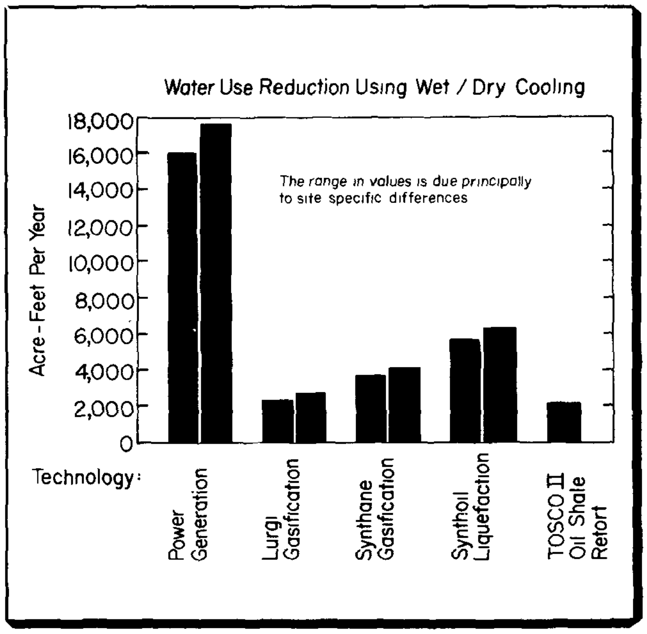
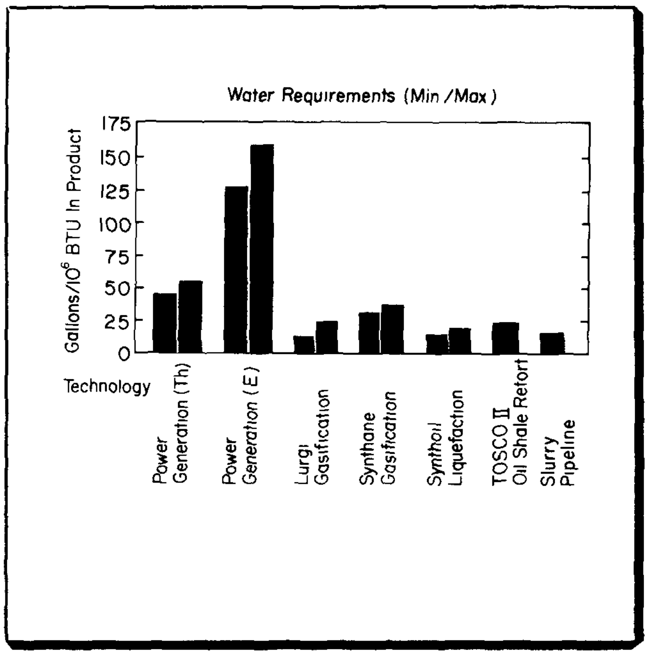
- Wet cooling can account for up to 96 percent of the total water requirements for energy conversion. The use of wet/dry cooling can reduce overall water consumption by 70 percent.

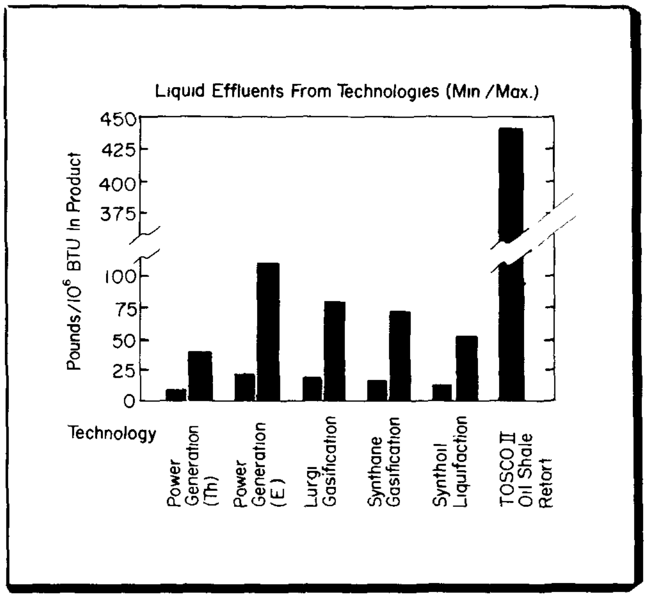


- Electric power generation consumes more water than does any other conversion technology on a per unit of energy produced basis.



- Water requirements for mining and reclamation are an order of magnitude less than for mine-mouth conversion.
- Without new impoundments to maintain in-stream flows, energy development in some areas will periodically deplete surface streams.

- Discharging effluents into on-site evaporative holding ponds can result in pollution of both surface and groundwater from seepage. Pollutants will be concentrated, pose a solid waste disposal problem, and, in the event of pond failures, can have adverse health,
6 ' ecological, and water quality effects.



- Energy related population increases will generally overload existing sewage and wastewater treatment facilities.
- Septic tank and lagoons will be widely used and the release of inadequately treated wastes will adversely affect water quality.

The following are among the policy implications of these findings:

- Existing mechanisms for resolving water use conflicts are likely to be inadequate when water demands exceed in-stream flows.
- Water shortages and conflicts among users are less likely to occur if water minimizing process designs and wet/dry cooling are required, particularly for water intensive technologies.
- Regulations specifying on-site evaporative holding pond design, management, and abandonment procedures may be required.
- Western communities will generally require more funding assistance for wastewater treatment than they are now receiving, if water quality problems resulting from municipal wastes are to be avoided.

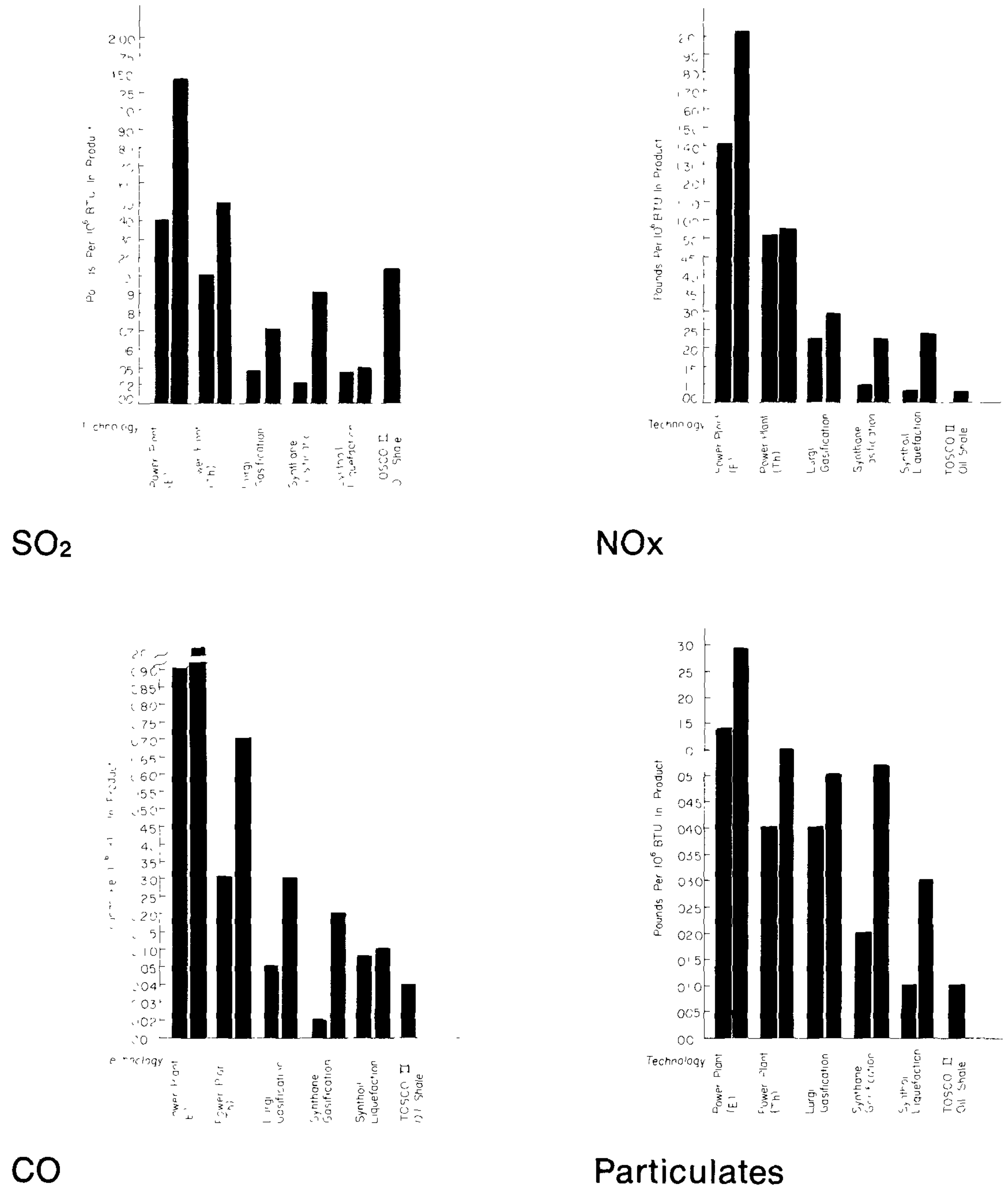
Air Quality

Air quality impacts can vary significantly due to the quantities of pollutants emitted, size of the work force required, characteristics of the energy resource, emission control technologies, dispersion potential, and topography. For example, emissions quantities contribute directly to the ambient concentration of pollutants; labor intensive technologies cause greater overall population increases, thereby affecting urban air emissions, particularly from increased automotive traffic and residential heating and cooling; coal composition affects the kinds and quantities of air emissions; dispersion potential helps to determine whether air emissions will produce an air quality problem (mixing conditions and wind, for example, will affect ambient concentrations); and high ambient concentrations can occur when a plume impacts elevated terrain. In the impact analyses conducted during the first phase of the study, we found that:

- Electric power plants emit more and coal conversion facilities emit less SO_2, NO_x, CO, and particulates than do other energy conversion facilities.

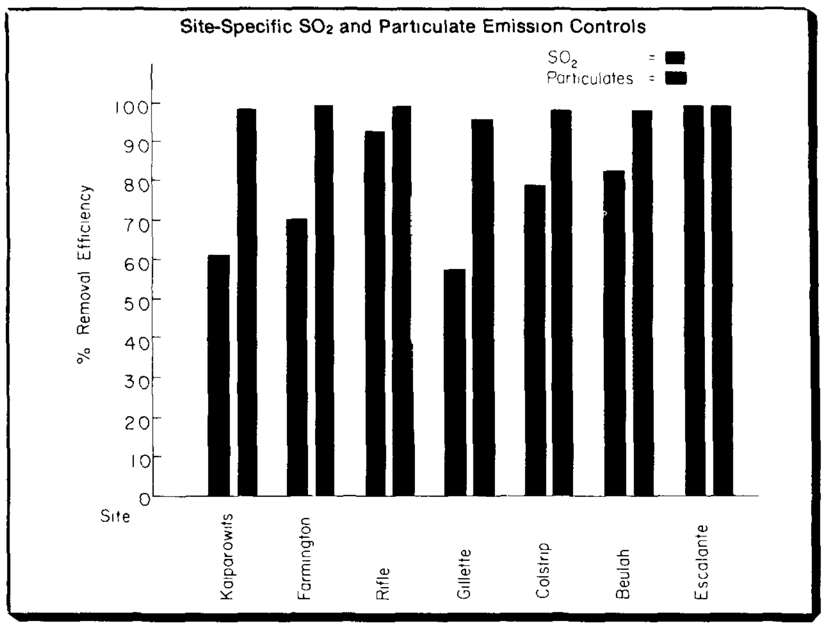
Air Emissions (Min./Max.)

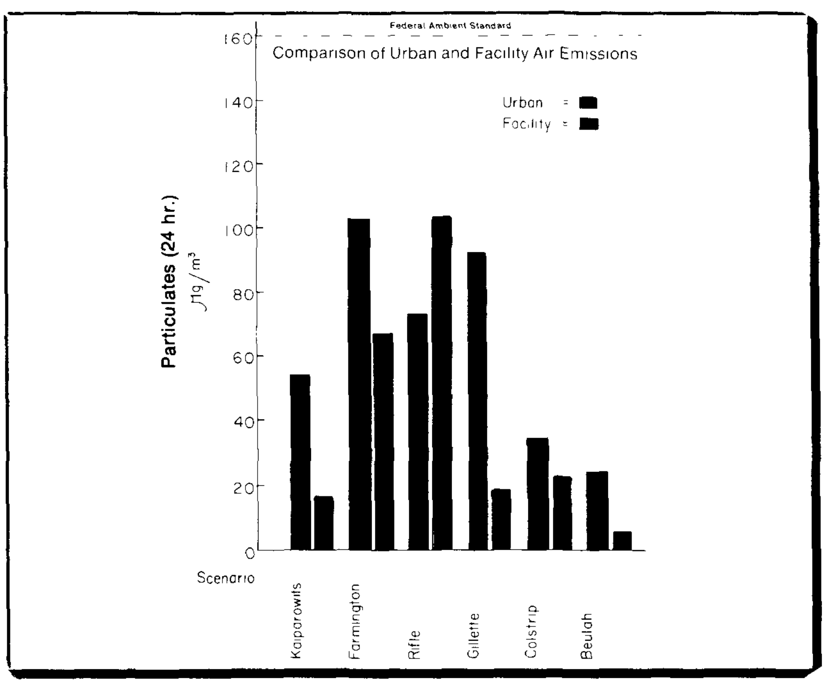
The Ranges in Valves are due principally to site specific differences.



- At most western sites, electric power plants will require both electro-static precipitators and SO_2 scrubbers to meet all federal and state air quality standards.

- Increased urban population generally produces higher peak ground-level ambient concentrations of particulates, NO_x, and hydrocarbons than those resulting from the energy facilities themselves.





- Fugitive hydrocarbon concentrations resulting from oil shale retorting, liquefaction, and natural gas production are expected to exceed the federal ambient standard.

Some of the policy implications of these findings are:

- More stringent Non-Significant Deterioration requirements or redesignation of large Class II areas to Class I can significantly affect the development of western energy resources both in terms of siting and facility size. For example, developers might opt for smaller power plants than are now being constructed.

- As noted above, the level of environmental controls that will be required at most western sites is high. One reason that particulate removal technology will have to be efficient is because background levels are high, primarily as a consequence of blowing dust. Background levels of hydrocarbons from natural sources are also high. Ambient standards for these two criteria pollutants are already being reevaluated for the western region.

Social, Economic, and Political

Impacts in this category can vary significantly due to variations in the labor and capital intensity among technological alternatives, construction schedules, the size and location of impacted communities, and local cultures and life styles. Increases in population will be directly related to the labor intensity of energy facilities; increases in public revenues will depend to a great extent on capital intensity, the population increase associated with most developments is greatest during the peak construction period. Coordinating the construction schedules of developments within the same local area can minimize the dislocating effects of the wide variations in population that might otherwise occur. The impacts resulting from large rapid increases in population are most severe in small, isolated communities. The dislocating effects on local cultures and life styles are also likely to be most noticeable in these areas and when distinct ethnic or religious groups are affected.

Some of the major findings resulting from the impact analyses performed to date are:

- Population-related impacts will be greatest with coal gasification since it is the most labor intensive of all the conversion technologies. It is also the technological alternative with the greatest difference in work force requirements during construction and operation.

- All conversion technologies are capital intensive and, over the long term, can produce public revenues in excess of capital and operating expense requirements. However, unless remedial action is taken, timing and distribution will often be a problem. Most revenue needs usually occur several years before tax revenues are available and increased revenues often go to a jurisdiction other than the one that has to provide most of the services and facilities, for example, to the county rather than to the town.

- Competition for assistance dollars, the lack of a professional staff knowledgable about assistance programs, and the failure of many such programs to be responsive to energy-related impacts will mean that most western communities can expect to receive very little assistance in responding to the impacts of energy resource development.

The following are among the policy implications of these impacts:

- Coordinated construction schedules will require close cooperation between energy developers and local governments. The development of new formal and/or informal mechanisms to facilitate public-private cooperation in planning and to mitigate impacts may be desirable, for example, in housing, public services, and health care.

- Present tax laws, debt limits, and financing procedures will need to be changed in some states if expanded service and facility needs are to be met during the early stages of development.
- In order for towns to provide necessary urban services, policies to redistribute tax revenues from counties to municipalities, new revenue sources, and/or new state/federal assistance programs may be required.

Ecological

Ecological impacts can vary significantly depending upon the land, water, and labor requirements of a technology and its air emissions and water effluents. The climate, topography, soils, and plant and animal communities at the development site can also help to determine the ecological effects of an energy development. For example, the significance of land consumption depends not only on the quantity of land consumed but also on the plants and animal communities that are displaced and whether they are unique or endangered. Some of our findings in this impact category are:

- Underground oil shale mining consumes two to six times as much land as any other mining technology. Electric power plants require more land than do any other conversion technology.
- Land consumption for energy development is relatively small; however, rare habitats or species may be affected. Aquatic habitat, critical to many species, is limited in the study area.
- Ecological impacts from energy-related population increases are usually greater than those from energy facilities themselves. Urban and energy development will frequently fragment habitat, make access to wild areas easier, and increase recreational activities such as hunting and the use of off-road vehicles.
- In some development areas, using surface waters for energy facilities can eliminate some sport fish and alter the aquatic communities supporting other fish.
- In some areas such as the arid southwest, reestablishing vegetation on strip mined lands will require a long term committment to irrigation and to controlling grazing.
- Emissions of sulfur dioxide from some energy developments such as large oil shale facilities can result in local damage to vegetation in hilly or mountainous areas.

Some implications for policy makers are:

- More stringent control over access and restricting or prohibiting certain uses on public lands can minimize many of the energy-related ecological impacts.
- Stringent land use and siting controls will be required if the destruction of rare habitat and endangered species is to be avoided.
- It may be necessary to limit water withdrawals or control the construction of impoundments at some sites in order to avoid depleting in-stream flows.

Other Impacts

Impacts in four other categories — health, transportation, noise, and aesthetics — were assessed for the eight-state study area. The principal findings were:

- Significant health hazards are not expected to result from air or water discharges of trace elements and radioactive isotopes. A possible exception would be the release of mercury into ecosystems supporting sport fish.

- The health effects of airborne sulfates depend on the rate at which emissions are converted to sulfates. A 3-percent conversion rate would not produce hazardous concentrations; a 10-percent rate could result in respiratory diseases.

- Rail transport systems are less capital intensive than coal slurry systems and are more flexible in terms of fluctuating demands and delivery to multiple destinations. However, slurry pipelines may still have lower overall costs when large volumes are shipped over a single route.

- 770 acre-feet of water are required for each 1 million tons of coal transported by slurry pipeline. By the year 2000, as much as 300 thousand acre-feet per year could be required for lines originating in the Northern Great Plains.

- New gas pipelines will be needed in the Northern Great Plains, primarily for synthetic natural gas.

- The most significant noise impacts will occur within one-half mile of rail lines, where noise levels above the annoyance level of 55 decibels will occur.

- Strip mines and transmission lines will result in visual intrusions that are aesthetically displeasing to many individuals. Conversion plants will produce opaque plumes and noticeably reduce long-range visibility.

- Aesthetic problems will most likely be perceived when energy developments are located in or near "pristine" areas, such as national parks, forests, and wildernesses.

COMPLETING THE WESTERN ENERGY STUDY

The emphasis of the research reported here has been on impact analysis. The results of these impact analyses has been briefly summarized above. Additional impact analysis is to be done, primarily by adding additional technological alternatives and undertaking sensitivity analyses to further the identification of critical factors. However, the major focus for the remainder of the project is to be on policy analysis. A series of policy analysis papers is now being prepared and drafts of these papers will be widely distributed to solicit comments and suggestions.

Several other reports are also being prepared. These include:

1. Energy Resource Development Systems for a Technology Assessment of Western Energy Resource Development. This report describes the six energy resources, where they are located, their quantities, and characteristics, the technologies for developing them, the inputs and outputs of these technologies, and the laws and regulations that will control their deployment. This background and supporting report will be available in late 1977.

2. The Impacts of Western Energy Resource Development. A final impact analysis report incorporating a number of extensions and refinements to the analyses reported in this Executive Summary will also be available in late 1977.

The final project report will be a synthesis of results drawn from four major sources: The Energy Resource Development Systems and Impact reports listed above, the series of policy papers, and several subcontractor reports. A draft of the final report will be distributed widely for comment in early 1978 and the final report will be distributed by late 1978.

For copies of the full report or further information, contact:

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