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Integrated Assessment of Texas Lignite Development

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AN INTEGRATED ASSESSMENT OF TEXAS LIGNITE DEVELOPMENT

VOLUME IV - EXECUTIVE SUMMARY

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FOREWORD

Recent years have witnessed increasing awareness of the declining availability of our most widely used energy sources - oil and natural gas - accompanied by sharp increases in price. Both direct government policy and the market price mechanism are now operating to stimulate a shift away from oil and natural gas to other fuels wherever possible. One area in which this shift is likely to be especially pronounced is the Gulf Coast. There, massive electric utility and industrial capacity is fueled by oil and natural gas which have historically been locally plentiful. Assuming this shift continues, other fuels will be required to power both new and existing sources. One promising candidate to fill much of the emerging energy gap in the Gulf Coast region over the near and medium term is lignite which exists in the same general region and appears to be very competitive economically. There are, however, significantly different and more serious environmental consequences associated with extraction, transportation, and utilization of large quantities of lignite than is the case for oil and natural gas.

Thus, this study was conceived as a timely first attempt at defining and analyzing the consequences and constraints associated with the potential extensive use of lignite in Texas (which comprises a major portion of the region in question), and the public policy options available for managing this development. A notable feature of this research effort has been its cooperative interagency character. It has been a valuable experience in federal/state research cooperation between the Department of Energy (DOE) and the Environmental Protection Agency (EPA), two federal agencies for which cooperation is essential in this sensitive policy area, and the Texas Energy Advisory Council, an agency of the State of Texas. In addition, active involvement of the DOE and EPA regional offices was incorporated into the design and management of the study. Efforts required to establish this complex structure were amply compensated for by the range of viewpoints and experience brought into the research design.

The study has been conducted under demanding constraints of both funds and time. The time constraint has been an especially difficult one. From the study's inception, it was agreed that major users to whom this study would be directed were state and local policy makers (although appropriate elements of the federal government, including regional offices, are considered to be major users as well). In that context it was considered essential that the study results be available to the 1979 session of the Texas State Legislature (which meets once every two years). Consequently, only eight months were available to complete this research, limiting the level of detail at which lignite development issues could be examined.

A significant decision made early in the study's planning was to emphasize the aggregate, regional impacts rather than the specific impacts associated with a single mine or power plant. This decision was based on two primary factors. First, because of its geologic and geographic distribution, lignite's development will occur over a broad region of Texas rather than be concentrated in a few limited areas. As such, it was felt that an analysis of the regional impacts of lignite development might yield valuable

information not recognized at the level of an individual site. Second, the attempt to hypothetically site future plants at a more detailed geographic level was too complex a task to be completed in a credible manner within the constraints of the study.

Given this perspective, the study team has done an excellent job of analyzing a number of constraints to and consequences of lignite development at the regional level and has pointed out many potential problems which deserve examination at a finer level of detail. Many environmental problems do not become apparent in an analysis at the regional level of aggregation although their cumulative impacts may be substantial. This study should, therefore, be viewed as a "first cut" overview of the issues associated with Texas lignite development. A finer grained analysis is still required in future research studies as well as through the permitting process.

The reader should also be sensitive to the effect of assumptions on conclusions in a study such as this. It was necessary, of course, to make assumptions about a wide range of future social and economic conditions in order to assess the potential impacts of lignite development. Varying these assumptions could substantially alter the study's conclusions. One clear example relates to availability of water for lignite development. Assumptions were made concerning future municipal and agricultural water demand and future development of dams and other measures to augment water supply. Given these assumptions, water availability does not appear to pose a significant constraint to lignite development in most areas of the lignite belt. Other assumptions, however, could have resulted in quite different conclusions. It was not possible within the limits of the study to examine the sensitivity of conclusions to variations in many such assumptions. The reader should, therefore, be aware of the context of assumptions in which these conclusions were drawn and the resulting limits on their predictive validity.

The project team, put together by the Radian Corporation, is to be congratulated for producing a thought-provoking technical and policy analysis report. In addition, special thanks are due to all members of the review panel and to Bill Honker and Mike Gibson of EPA's Dallas Regional Office and Lila Williams of DOE's Dallas Regional Office for unselfish commitments of time and experience to the project.

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I. INTRODUCTION

Lignite viewed as transition fuel

Texas lignite is widely perceived by policymakers and the public alike as a "transition fuel" bridging the gap between the depletion of the state's oil and gas reserves and the commercialization of the clean, renewable energy sources of the 21st Century--fusion, solar, wind, and geothermal.

Lignite is potentially important to state's energy-intensive industrial base

Scarcely a decade ago, Texas lignite was a virtual unknown--except to a handful of energy companies quietly acquiring leases. Then in the wake of the 1973 Arab oil embargo, the five-fold increase in world oil prices, and natural gas shortages, Texas lignite was hailed as a "new" indigenous source of energy capable of sustaining both the state's energy-intensive industrial base and its traditional role as an exporter of oil and gas.

During 1970's lignite production increased ten-fold

During the 1970's, Texas lignite production has increased ten-fold as the state's electric utilities and more recently, industry, began a shift from near total reliance on oil and gas to lignite and imported western coal.

This conversion has been prompted by economics and by state and national policies which reduce the availability of oil and gas for electric utility and industrial uses. These two sectors account for more than two-thirds of all energy consumed in Texas.

Industry and electric utilities find lignite an attractive alternative to coal and nuclear

In the late 1970's, Texas lignite has emerged as a preferred alternative fuel for most of the state's utility and some industrial fuel users as legal and regulatory developments tended to close off the nuclear option and reduce the attractiveness of imported western coal.

Transition to lignite and coal raises environmental concerns and policy questions

The rapid shift to lignite and coal has raised environmental concerns and a variety of policy implications. In an effort to determine the extent of these impacts and to assess the relevant policy issues, the Texas Energy Advisory Council (TEAC) together with the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DoE) sponsored this integrated assessment of Texas lignite development.

The assessment was conducted by Radian Corporation of Austin, Texas, assisted by a review panel comprised of some thirty representatives from government, industry, academic and public interest groups, and sponsoring agencies.

This study was conducted in four steps:

This document summarizes the results of the study. It is organized along the lines of the four major steps--or tasks--involved in the assessment.

How much lignite development?

- The *Development Scenario* task (Section II) attempts to determine how much lignite development might occur and what factors influence this development.

What are siting constraints?

- The *Siting Analysis* task (Section III) seeks to determine where lignite and coal use is likely to occur and whether the projected number of lignite and coal facilities can be accommodated given several key siting limitations.

What are impacts of lignite development?

- The *Impact Analysis* task (Section IV) identifies probable environmental and socioeconomic impacts which are likely to occur based on the magnitude of development and siting patterns indicated in the first two tasks.

What are the policy issues and alternatives?

- The *Policy Analysis* task (Section V) identifies the major policy issues which relate to each of the three preceding tasks and assesses alternative means of resolving the issues based on various policy objectives.

II. LIGNITE DEVELOPMENT SCENARIO

Method of Analysis

To estimate scale of development, overall energy growth and the roles of various technologies were assessed

To evaluate plausible scales of lignite development during the remainder of the 20th Century, the study team looked first at the probable future uses of lignite and then attempted to estimate the demand for lignite in these sectors. This required an assessment of the following factors:

- Overall energy growth rates,
- The role of conservation and alternative, renewable fuels,
- The role of nuclear power,

- The availability and future use of oil and gas,
- The amount of solid fossil fuel demand which will be satisfied by lignite, and
- The extent and ownership of the lignite resource.

Several sensitivity cases were examined

A variety of sensitivity or "what if?" cases were examined to determine what factors might significantly alter the future scale of lignite development. Finally, a reasonable or "nominal" case was selected upon which to base the siting and impact tasks.

Results and Conclusions

Texas' overall energy growth rate will probably continue to exceed national rate

Growth in the state's overall energy demand, in general, and electrical demand, in particular, is expected to exceed national rates. However, both national and state growth rates are expected to be below those of the pre-embargo period. It is anticipated that lignite use will be confined entirely to the utility and industrial sectors. The development scenarios focus on these two sectors.

Texas electric utility fuel use expected to increase from 1.8 Quads to 4.8 Quads in 2000

The nominal case calls for Texas electric utility generation to grow by 5.3 percent per year from 1978 to 1987 and by 4.3 percent from 1987 to 2000. These rates, which represent the current projections of the state's utility industry, would increase energy consumption by the state's electric utilities from 1.8 quadrillion Btu's (Quads) in 1978 to 4.8 Quads in 2000.

Texas industrial fuel use expected to increase from 2.4 Quads to 5.2 Quads in 2000

The nominal case for industrial energy consumption is consistent with earlier forecasts by TEAC and DoE, based on projections of economic activity. The rates used for industrial energy consumption (primarily process heat, process steam and on-site electrical power production) are 3.8 percent per year for the 1975-1990 period and 3.2 percent annually for 1990-2000. This growth results in an increase in industrial consumption from 2.4 Quads in 1978 to 5.2 Quads in 2000.

Table 1. DERIVATION OF SOLID FOSSIL FUEL REQUIREMENTS

	1978	1985	2000 High	2000 Nominal	2000 Low
	(10^{15} Btu's or Quads)				
Total Conventional Energy Requirement					
Utilities	1.76	2.6	5.4	4.8	3.3
Industry	2.42	3.1	6.5	5.2	3.3
Exempted Oil and Gas Use					
Utilities	1.26	1.3	1.3	1.3	1.3
Industry	2.37	2.9	4.6	4.0	3.0
Prospective Nuclear Supply					
Utilities	0.0	0.3	0.4	0.4	0.4
Solid Fossil Fuel Requirement					
Utilities	0.50	1.0	3.7	3.1	1.6
Industry	0.05	0.2	1.9	1.2	0.3

The top two lines of figures in Table 1 show this increase in energy consumed, together with a "high" and "low" case. Since the nominal case estimate is the basis of this overall assessment, it is instructive to examine the effects of scenarios which either continue current growth rates into the 1990's (high case) or which assume a rate of growth which is equal to the state's projected population growth (1.7 percent per year) in the 1987-2000 time frame (low case).

Energy conservation and renewable energy sources could significantly reduce future fossil fuel requirements

The almost two-fold difference in year 2000 energy consumption between these low and high cases illustrates how conservation efforts and the substitution of renewable (non-conventional) energy sources can reduce the scale of future energy development.

High ambient levels of ozone could impede growth in refining and petrochemical industries

Aside from voluntary conservation, a major factor which could reduce overall industrial energy growth, particularly in the Gulf Coast petrochemical and refining industry, is the national policy which discourages new industrial growth in areas which do not meet air quality standards. The principal air quality nonattainment problem in Texas relates to the high levels of photochemical oxidants or ozone. The nominal case assumes that the recent relaxation of the ozone air quality standard coupled with the state's control strategies will allow continued industrial expansion to occur.

Following the determination of plausible utility and industrial energy requirements, the next step in deriving an estimate of future lignite development was the estimation of the utility and industrial energy requirements that would likely be met by oil and gas, nuclear and solid fossil fuels.

Regulatory constraints on utility and industry oil and gas use is an important variable in future lignite development

The second pair of lines in Table 1 indicate the amount of oil and gas that would be consumed by utilities and industry in 1985 and 2000 under the nominal case. The figures show that the amount of oil and gas used by utilities will remain level while industrial use of oil and gas will increase by 70 percent from 1978 to 2000. This estimate assumes that utilities and industry will respond to the National Energy Act's mandatory boiler fuel conversion provisions (Fuel Use Act) as follows:

- New utility power plants will rely primarily on lignite, coal and nuclear fuels. Some use of oil and gas will be allowed in new power plants in order to maintain system reliability.

- Some existing utility power plants will receive conversion exemptions based on environmental or economic grounds, and some will continue to use gas for peaking purposes. None will convert directly to coal or lignite.

- New industrial boilers built after 1982 will use coal, lignite or gaseous fuels derived from coal or lignite.

- New industrial process heat demands will continue to be met by either oil or gas.

- Existing industrial boilers are currently exempt by law from conversion requirements and assumed to remain exempt.

Pressures to convert to coal and lignite are a function of domestic and foreign gas supplies and the security and price of foreign oil imports

The nominal case assumes a moderate approach to implementation of the Fuel Use Act. Forces which may tend to relax the mandatory boiler fuel conversion policy are:

- Prospects of large and secure supplies of Canadian and Mexican gas,

- Surpluses of domestic gas,

- Concern over environmental impacts from rapid conversion, and

- Concern over the economic impacts of forced conversion.

On the other hand, future disruptions of oil imports and OPEC price increases may result in strict enforcement of the Fuel Use Act as a means of reducing vulnerability to foreign oil producers. Such a scenario would increase lignite and coal use in Texas.

Nuclear power growth expected to stagnate

The nominal case assumes a rather pessimistic future for nuclear power with no new nuclear units added beyond those already under construction or expected to be on line by the late 1980's. The 0.4 Quads contributed by nuclear in the year 2000 nominal case amounts to about eight percent of the state's electric utility generation.

The last two lines in Table 1 indicate the conventional energy requirements of utilities and industry which would be met by solid fossil fuels (coal or lignite) under the high, nominal, and low cases.

The competition between Texas lignite and imported coal is influenced by policies related to:

These solid fossil fuel requirements can be met by either lignite or imported coal. The proportion of demand satisfied by either coal or lignite depends on several economic and regulatory variables. These include:

• Air Quality

- *The universal scrubbing requirements proposed to comply with the Clean Air Act Amendments of 1977*, which have removed the primary advantage of low-sulfur western coal--the ability to meet emission standards without the installation of costly flue gas desulfurization units (scrubbers).

• Coal Transportation

- *Rising rail transportation rates*, which have more than offset the relatively low mine-mouth costs of western coal (vis-a-vis lignite). Rate increases by rail carriers supplying coal-fired utilities have far exceeded the general rate of inflation. Transportation now accounts for almost three-quarters of the delivered price of western coal to Central Texas. By contrast, Texas lignite can be consumed at the mine-mouth, thus avoiding transportation costs.

• Coal Leasing

- *Federal coal leasing policies*, which will affect the availability of western coal. More than two-thirds of the coal from the Rocky Mountain West (currently the only major source of imported coal to Texas) is owned by the federal government. A restrictive leasing policy will reduce the availability of western coal.

• Surface Mining

- *Implementation of federal surface mining and reclamation legislation*, which can increase the costs of surface mining. While the regulations will apply uniformly across the nation, it is believed that the per-ton reclamation and compliance costs will be higher in arid and mountainous regions of the West than in the Texas lignite belt.

These policies increase the attractiveness of lignite

An analysis of current plans for the use of coal and lignite by utilities in Texas indicates that through 1987, approximately 60 percent of the solid fossil fuel demand will be met by lignite. The factors listed above all tend to *increase* the competitiveness of lignite over western coal. Thus, it appears that in the time frame of this study, lignite will continue to be the preferred fuel over imported coal. However, in the post-2000 era, lignite use may be surpassed by western coal as lignite reserves are depleted. By 2000, coal may also be imported from the Midwest.

Current plans show that lignite will satisfy about 60 percent of Texas electric utilities' future solid fossil fuel requirements

Table 2. POTENTIAL REQUIREMENTS FOR LIGNITE COMMITMENT

		1978	1985	2000
Total Energy Required (10^{15} Btu's or Quads)	Utilities	1.8	2.6	4.8
	Industry	2.4	3.1	5.2
Solid Fuel Demand (10^{15} Btu's or Quads)	Utilities	0.50	1.0	3.1
	Industry	0.05	0.2	1.2
Lignite Demand (10^{15} Btu's or Quads)	Utilities	0.30	0.6	1.9
	Industry	0.05	0.1	0.7
Lignite Reserve Commitment Required (Billions of Tons @ 6500 Btu/lb	Utilities	0.70	1.4	4.4
	Industry	0.10	0.2	1.6
	Total	0.80	1.6	6.0

At projected rate of development, the strippable lignite reserves may be fully committed shortly after 2000

Table 2 indicates how much lignite must be committed to meet the solid fossil fuel demand by year 2000 for utilities and industry in Texas. These data assume that the 60/40 proportional split between lignite and coal use will continue for utilities and will also be reflected in industrial solid

fossil fuel use. It is significant to note that by year 2000, approximately six billion tons must be committed to fuel the assumed 30-year lifetimes of the industrial and utility boilers which are being constructed through the year 2000. The Texas Bureau of Economic Geology estimates the state's economically recoverable lignite reserves at 6.7 billion tons.

Lignite use expected to increase ten-fold to 200 million tons per year by 2000

The nominal case implies a ten-fold increase in lignite production from a current level of about 20 million tons annually to a maximum of about 200 millions tons per year.

Table 3. SENSITIVITY OF LIGNITE COMMITMENT BY THE YEAR 2000 TO ALTERNATIVE ASSUMPTIONS

	Utilities (Billion Tons)	Industry (Billion Tons)	Total (Billion Tons)
Nominal Case	4.4	1.6	6.0
High Growth	5.2	2.6	7.8
Low Growth	2.2	0.4	2.6
High Nuclear; Moderate Growth	2.8	1.6	4.4
Constrained Gas & Oil; Moderate Growth	6.1	2.5	8.6
Moderately Constrained Gas & Oil; Moderate Growth	6.1	1.6	7.7
High Lignite Demand for Utilities; Moderate Growth	5.1	1.6	6.7
3% Annual Boiler Retirement Rate	5.1	2.5	7.6
Estimated Strippable Reserves to 150 feet (currently economical)	. . . . .		6.7
Estimated Strippable Reserves to 200 feet	. . . . .		8.9

There are two major uncertainties which could either hasten or delay the depletion of the resource:

The split of solid fuel supply between lignite and western coal is uncertain

- The various policy and economic trends which now appear to favor lignite over western coal could easily increase the currently projected 60/40 lignite-coal ratio such that proportionately more lignite is used and the resource commitment exceeds six billion tons well before 2000.

Technology and continued exploration could increase recoverable lignite resource

- On the other hand, the economically-recoverable resource estimate could increase

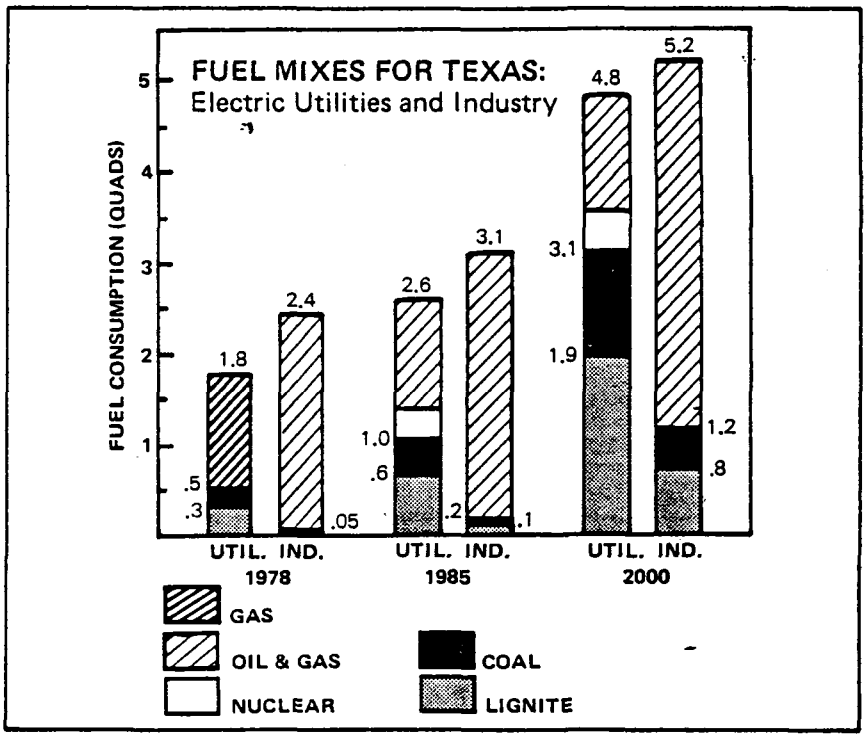


FIGURE 1

significantly as prices rise and technological advances permit recovery of lignite at greater depths and in thinner seams. Additional exploration may also increase resource estimates.

It is likely that both of these trends will develop concurrently. To the extent that the proportional increase in lignite demand cancels out the increase in recoverable lignite resources, the state may still face the prospects of committing most of its lignite reserves by the turn of the century.

Mandatory boiler fuel conversion policies could increase lignite requirements

It is useful to consider factors influencing the overall demand for energy and solid fossil fuels. Table 3 shows the effect of alternative assumptions on the rate of lignite commitment by 2000. Either a lower overall energy growth rate or a higher reliance on nuclear would reduce this resource commitment. By contrast, a strict interpretation of the Fuel Use Act (triggered by constrained oil and gas supplies) or higher overall growth rates in energy demand would increase the rate of lignite commitment. Figure 1 displays the nominal case estimates for utility and industrial fuel mix patterns in 1985 and 2000. The continuing importance of oil and gas--particularly for industrial use--is evident.

Lignite and coal facilities were distributed among five subregions

The final steps in the development scenario task were to geographically apportion the statewide levels of lignite use through 2000 into the five subregions (see Figure 2). Based on utility plans through 1987, current leasing patterns, and other data, lignite use under the nominal case results in the equivalent of 21 lignite-fired utility power plants and 13 coal-fired power plants--each composed of three 500 Mw units--through the year 2000. This distribution, including industrial use, is shown in Table 4 and indicates the following:

Most industry use of coal and lignite expected in Gulf Coast subregion

- The majority of the industrial coal and lignite use will be in the Gulf Coast subregion, reflecting the state's current industrial energy use patterns.

Lignite-fired power plants will site along lignite belt

- Lignite-fired utility facilities will tend to locate on or near the lignite belt using mine-mouth plants to take advantage of transportation savings.

Coal used in western part of the state will be imported

- Coal used in the western part of the state will be imported, reflecting the increased distance from the lignite belt and decreased distance from western coal supplies.

Electric utilities will continue to use conventional combustion technology through 2000

Utilities are expected to continue to use conventional combustion systems throughout the study period. The commercial use of atmospheric fluidized bed combustion units in industry may occur beginning in the 1990's.

Lignite gasification may become commercial before 2000

Lignite gasification may also become commercial. This depends heavily on the interaction of policies regarding fuel use and environmental protection.

Table 4. 1985 AND 2000 DISTRIBUTION BY SUBREGION OF HYPOTHETICAL 500 MWe EQUIVALENT COAL AND LIGNITE FACILITIES

		West	Northeast	North Central	South	Central	Gulf Coast	State Total
(Numbers in parentheses are nearest equivalent to a 1500-MWe generating station.)								
Coal Utilities	1985	4(1)	2(1)	2(1)	0	2(1)	4(1)	14(5)
	2000	12(4)	6(2)	4(1)	0	7(2)	12(4)	41(13)
Lignite Utilities	1985	0	10(3)	7(2)	3(1)	1(1)	0	21(7)
	2000	0	32(11)	20(7)	6(2)	3(1)	1(1)	62(21)
Coal Industrial	1985	.2	.1	.2	0	0	1.5	2
	2000	1.4	.7	1.3	.2	.2	11.2	15
Lignite Industrial	1985	0	.5	2.	0	0	.5	3
	2000	2.1	5.3	6.2	.3	.4	8.7	23

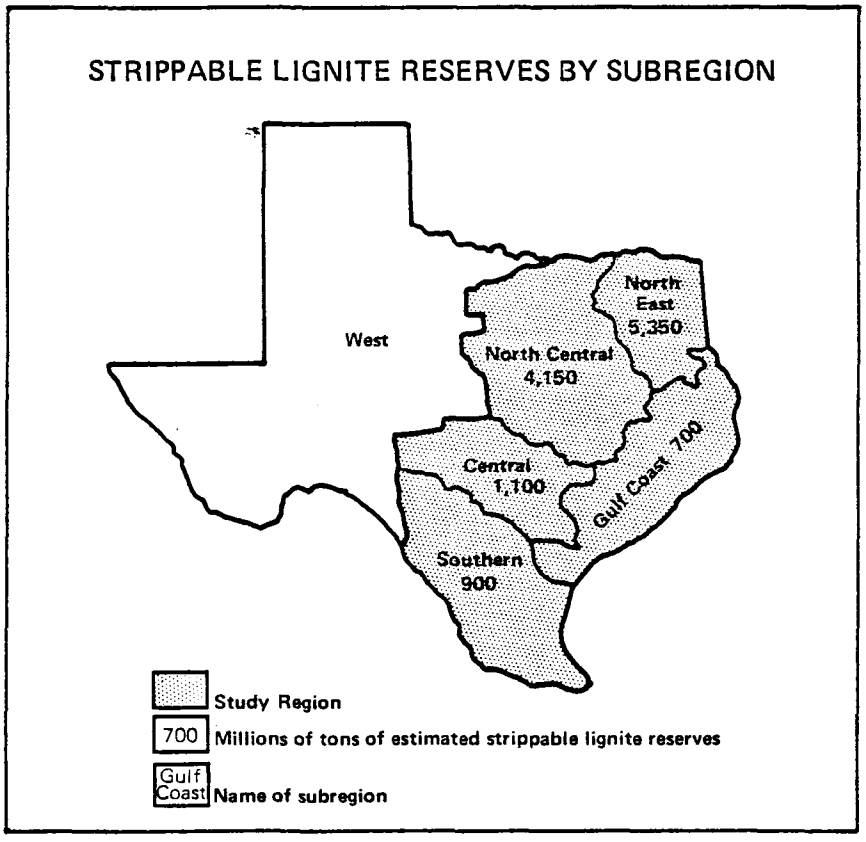


FIGURE 2

III. THE SITING ANALYSIS

Method of Analysis

Based on the development scenario described in Section II, the siting task attempted to determine:

The siting task looked at constraints on projected fuel use pattern

- If the projected hypothetical coal and lignite facilities could be sited in the study region and each of the five subregions, and
- What would be the most serious constraints in the siting process.

The study developed maps of six physical constraining factors

To evaluate the relative difficulty of siting large coal- or lignite-fired facilities, individual maps were developed to show geographic variations in the degree of constraint imposed by each factor. Then, the study region was divided into a grid of squares measuring about 20 kilometers on a side. Each square was assigned a value according to the degree of constraint imposed by each of six factors. The constraining factors were weighted according to their effect on siting costs and permitting difficulties. Based on this exercise, a computer-generated composite map

was produced to reflect the combined effect of all constraining factors on the costs and difficulty of siting (see Figure 4). The six constraints are:

- Water availability,
- Ambient air quality,
- Flood-prone areas,
- Urbanized areas,
- Geological foundation suitability, and
- Distance from lignite deposits.

Although aesthetic considerations and public attitudes can be significant siting barriers, these factors are not readily quantified and are not formulated into regulations that affect plant costs, site availability and permitting.

Results

Sufficient water can be developed regionwide, but site-specific shortages and water rights conflicts could develop

- *Water Availability* - According to Texas Department of Water Resource (TDWR) data, each of the five subregions can be developed to accommodate the water demands for lignite and coal development expected between now and the year 2000. Unless the projected schedule of water resource development is met, however, water shortages are likely to occur in several river and coastal basins by the year 2000 (Figure 5). Even with the timely development of these projects, some river basins may have difficulty supplying adequate water to meet all projected in-basin demands by the year 2000. Energy projects in some parts of Texas may only be feasible if water rights currently held by other users can be acquired by the developer of the energy project. The total water demand for coal and lignite development in the study region is expected to amount to 4.6 percent of year 2000 supply.

PSD regulations impose spacing requirements on coal and lignite facilities

- *Air Quality* - The siting of coal and lignite facilities is most directly affected by Prevention of Significant Deterioration (PSD) regulations established to maintain existing air quality in clean air areas. In effect, these PSD regulations tend to impose a minimum spacing pattern for coal- or lignite-fired facilities or other major sources of sulfur dioxide and

particulates--the two pollutants currently subject to PSD controls. For purposes of the siting analysis, it was assumed that each of the projected 1500-Mw facilities (three units of 500 Mw each) installs pollution controls for sulfur dioxide and particulates which meet EPA's proposed new source performance standards (NSPS). Using a variety of simplifying assumptions, it was estimated that in clean air areas, PSD would require typical 1500-Mw power plants to be separated by about 20 kilometers. However, air quality varies over the study region, as shown in Figure 3. This figure indicates the relative difficulty of siting coal- or lignite-fired facilities because of increased costs of compliance or difficulty in obtaining a permit.

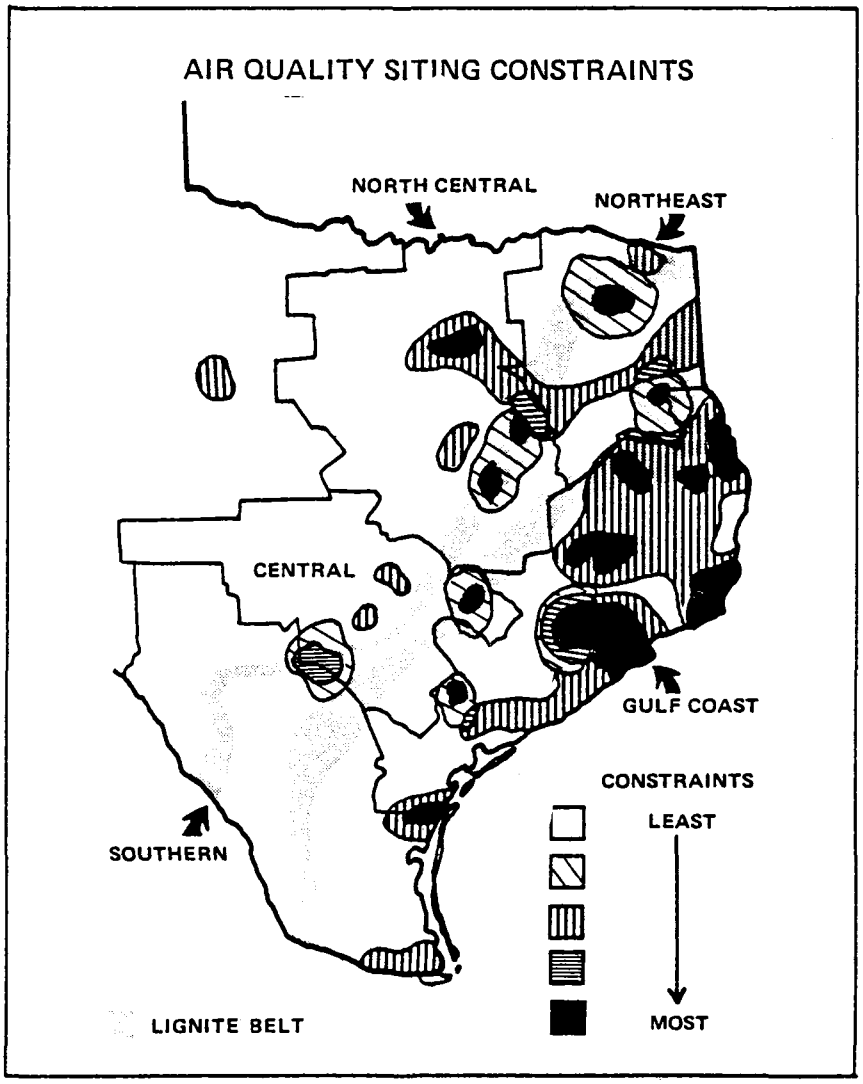


FIGURE 3

Current air regulations will not prevent needed plants from being sited

Considering the number of facilities required under the lignite development scenario, it was determined that, on a regional basis, there is no shortage of usable sites, although some may be more costly and difficult to permit. Emphasizing again, PSD, like water availability, will continue to act as a constraint on a site-specific basis. Nevertheless, it is theoretically possible to demonstrate sufficient sites at the regional and subregional level to accommodate the projected year 2000 scale of development.

Air quality rules may reduce siting flexibility and increase costs

Flood prone areas and wetlands impose constraints on mining lignite

- *Flood-Prone Areas and Wetlands* - Floodplain and wetlands regulations represent a constraint for both lignite mines and power plants. As much as ten percent of the strippable lignite resource may be affected by prohibitions on mining or development in these areas. Although under special conditions and at increased costs, mining probably can be conducted in the floodplain, it is possible that under federal or state law, some of these areas may be declared unsuitable for mining. The floodplain and wetland constraints are greatest in the more humid eastern portion of the state.

Urbanized areas represent only a minor siting constraint

- *Urbanized Areas* - For a variety of reasons, the densely populated areas within the corporate limits and extraterritoral jurisdictions of cities are unlikely sites for future mines or power plants. Although urban areas in Texas are continuing to expand rapidly, this is not viewed as a major constraint to lignite development because of the small percentage of the state's area involved.

The best construction sites coincide with the lignite belt

- *Construction Suitability* - Data from the Texas Bureau of Economic Geology were used to prepare maps of the study region to show the suitability of geological conditions for construction of power plants and cooling ponds. Within the study region, the best areas for construction tended to coincide with the lignite belt. Construction suitability is not considered to be a constraint to the projected levels of lignite development.

The state's major utility and industrial demand centers are located near the lignite resource

- *Distance from Lignite Belt* - Currently, virtually all lignite use in the state occurs within a few miles of the mine. Lignite's low energy content per pound reduces the attractiveness of long-range transport. Nevertheless, the study indicates lignite may be shipped to the Gulf Coast and still compete with imported coal. The state's three largest cities, Houston, Dallas, and San Antonio, lie within 100 miles of some portion of the lignite belt. The major utility and industrial demand centers are within a reasonable distance of the lignite source.

The lignite belt is relatively less constrained than other areas in the study region

Figure 4 is the overall facility siting constraint map. It combines all of the factors described above with greater weighting on the more crucial factors such as air quality and water availability. This map shows that the lignite belt is relatively less constrained than the areas to either side. Of special note is the relatively high level of constraint existing in the industrialized coastal areas.

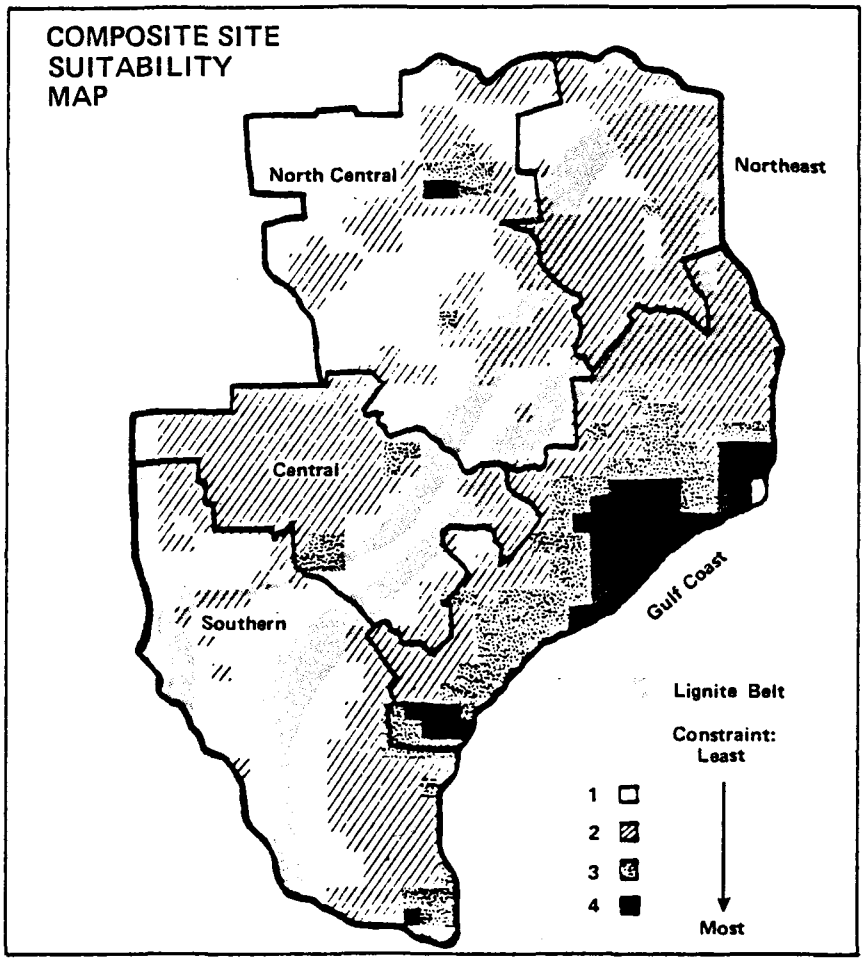


FIGURE 4

No regionwide barriers exist to the siting of the projected lignite and coal fired power plants

Conclusion

The siting analysis concludes that on a regional and subregional basis, there are no major barriers to siting the number of coal- and lignite-fired power plants which will be required to meet the estimated year 2000 energy requirements for utilities. Site-specific constraints, however, are likely to be significant. These may include local siting considerations below the level of detail considered in this study and the important, but unquantifiable, constraints imposed by the attitudes of local citizens and landowners.

IV. IMPACTS OF LIGNITE DEVELOPMENT

The anticipated impacts of lignite production and lignite and coal utilization between 1978 and 2000 were assessed in five major areas: air quality, solid waste, water quality and quantity, fish and wildlife, and socioeconomics.

Air Quality Impacts

Technology exists to meet current emission standards from lignite and coal combustion

Air pollutants from lignite mining include dust from surface mines and from coal piles. Air pollutants from lignite and coal combustion include particulates, sulfur dioxide (SO_2) and nitrogen oxides (NO_x) as well as small amounts of carbon monoxide, hydrocarbons and trace metals. Since Texas lignites generally have higher sulfur and ash contents than western sub-bituminous coals, potential emissions are greater. However, controls are available to substantially reduce emissions of all pollutants from combustion.

Currently, the study region is in attainment of the National Ambient Air Quality Standards (NAAQS) in both SO_2 and NO_x, but a few small areas are nonattainment for particulates.

Emissions of SO_2, NO_x and particulates will increase significantly

Even under the stringent new source performance standards proposed by EPA, coal and lignite emissions of SO_2 are expected to increase to 865,000 tons per year by 2000 or six times the 1973 levels. NO_x emissions would increase from 32,800 tons per year in 1973 to 1.3 million tons per year in 2000. Particulate emissions would increase from 30,000 tons to 75,000 tons in 2000.

The application of proposed new source standards will reduce potential emission levels

Although the increases in emissions are large, they are small compared to increases which would occur with the application of less stringent emission standards required for existing facilities.

Texas can accommodate projected lignite and coal development and comply with ambient standards

The key issue is not the total amount of emissions increase, but rather how net air quality will be affected. As noted in the previous section, the federal PSD regulations are designed to prevent significant deterioration of air quality within a given area while the NAAQS are established to protect public health and welfare. The principal conclusion of the air quality siting analysis was that the PSD and NAAQS requirements can be satisfied within the forecast level of lignite and coal combustion.

If it is assumed that these regulations are adequate to protect public health and welfare and that they will remain in force, it is concluded that there will be no significant air quality impacts from currently controlled pollutants resulting from lignite and coal utilization in Texas through year 2000.

Several areas of uncertainty remain regarding the effects of currently unregulated pollutants

Such a conclusion must be tempered by the uncertainties regarding the effects of fine particulates, sulfates, ratioactive emissions, and acid rain. The potential also exists for long distance transport of air pollutants. Continuing research in these areas is needed.

The clean-up of air emissions creates solid waste disposal problems

A by-product of the technologies employed to clean up air emissions from coal and lignite combustion is the creation of large amounts of solid waste--primarily scrubber sludges and ash. In principle, the transformation of air pollution to solid waste results in a more easily managed disposal problem. In fact, the potential for adverse health impacts from scrubber sludge and disposal is a source of significant concern. The principal concern over improper disposal is on groundwater quality. This concern is based on the following:

The disposal of solid wastes above aquifers could create ground water quality problems

- Evidence exists that groundwater contamination from improper disposal has occurred in the past.
- Groundwater is often used without treatment for drinking water.
- Contaminants from solid waste usually persist in groundwater indefinitely.

The amount of waste produced is proportional to the amount of coal or lignite combusted, the type of emission controls employed, and the degree of air emission cleanup. Based on the nominal case estimates for coal and lignite consumption and EPA's proposed NSPS, the amount of wastes

to be produced by utilities alone in the year 2000 could require 1600 acres of 20-foot deep disposal ponds.

A major concern regarding solid waste disposal in Texas is the coincidence of the lignite belt with one of the state's major aquifers, the Carrizo-Wilcox. Careful site selection and disposal techniques are needed to avoid threats of contamination as both groundwater use and waste disposal increase.

Solid waste disposal costs will increase

Proposed regulations for the federal Resource Conservation and Recovery Act (RCRA), designed to protect groundwater quality, could sharply increase disposal costs if ash and scrubber sludges are declared to be hazardous. A significant increase in costs could influence utilities to choose regenerable scrubbers, which have higher costs and lower reliability but produce no scrubber sludge. In either case, RCRA will raise the cost of waste disposal.

Opportunities for solid waste utilization exist

An alternative to disposal is recycling. Currently, about one-fourth of the lignite ash produced in Texas is sold for commercial uses--either in cement production or roadbed materials. Recycling reduces disposal area requirements and costs, but is not always feasible.

Solid waste disposal poses the most uncertainty among environmental issues

It does not appear that the solid waste disposal problems will limit the magnitude of lignite development. However, of all the regulatory issues associated with the environmental impacts of lignite and coal use, the solid waste picture is the most uncertain. In addition to RCRA, the Toxic Substances Control Act, the Safe Drinking Water Act and the State's regulatory role in waste disposal will influence the future solid waste disposal options available to coal and lignite users.

Water Quantity and Quality Impacts

Consumption of water to support lignite development will result in small but possibly important stream flow reductions

Water consumption for lignite development by the year 2000 is estimated to vary at the subregional level from an estimated 0.1 percent of total planned supply (in the Gulf Coast subregion) to more than 10 percent (in the Northeast). This consumption will result in reductions in stream flow, both near major diversions and cumulatively. These reductions can affect navigation, groundwater recharge, stream ecology, coastal freshwater inflows to bays and estuaries, and capacity to assimilate pollutants.

Although flow reductions are relatively small, they can be critical when flows are low during times of drought.

Also, because of highly variable site specific conditions, local impacts may be significant. Conflicts may develop over water rights and water quality. These impacts could be controlled, however, by timing withdrawals and reservoir releases to maintain a given low flow level.

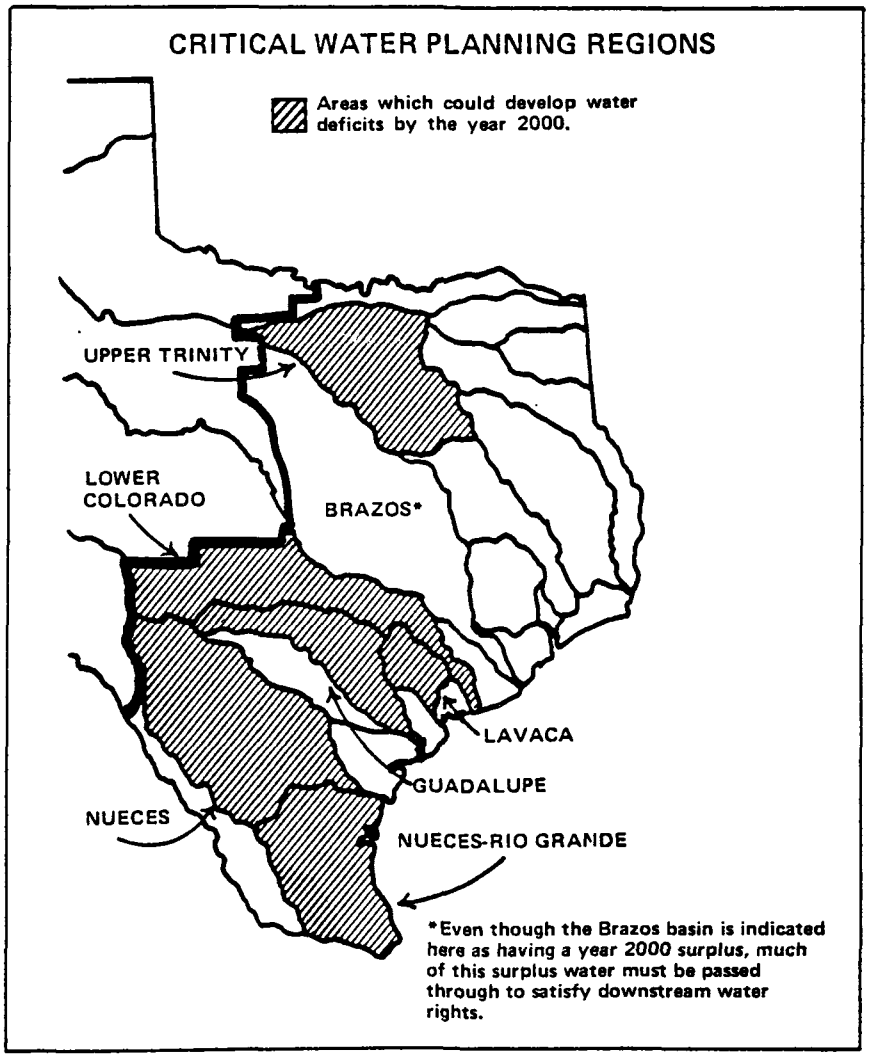


FIGURE 5

Surface water quality will be affected by lignite operations

Surface water quality will be affected by effluent sources associated with power plant operation and lignite mining. Power plant cooling, boiler blowdown, ash and scrubber sludge handling, and other power plant operations, will increase dissolved solids levels in return flows to receiving water bodies. Control of dissolved solids levels will, in turn, reduce the amount of water available for other uses. These effluents may contain toxic substances. However, technology is available for control of these effluents.

Surface mining could locally disrupt aquifer recharge

Surface mining in some parts of the state may result in a long-term reduction in groundwater recharge due to the

disruption of aquifer recharge areas. The permeability of a mined area will affect the degree to which groundwater quality problems develop. Likely processes of contamination are leaching of pollutants from disturbed overburden and from solid wastes disposed of in the mine. Of these, the greatest threat is from solid waste leaching.

Growing demand for surface water may increase demand on groundwater

It is expected that surface water will continue to be preferred for power plant cooling. Groundwater use may be indirectly increased, however, by growing competition for surface supplies. Most of the study region's aquifers already have both quality and drawdown problems arising from overpumping.

Wildlife and Fish Impacts

Wildlife impacts will result from surface mining, cooling ponds, and secondary developments

Major impacts on wildlife from lignite development result primarily from direct destruction of habitat caused by surface mining, removal of habitat by impoundments for cooling reservoirs, and reduction of habitat quality from the impacts of population growth.

Surface mining alone is expected to result in the cumulative disturbance of approximately 374,000 acres by year 2000. Approximately half of this is anticipated to occur in the Northeast subregion.

Current habitat quality is poor

Since the land will be reclaimed and revegetated within three years of mining, the amount of disturbed surface at any one time will be a small portion of the cumulative total. The total acreage which may be mined is less than one percent of the total habitat available. The real impact of lignite development, however, must be measured against the quality of the areas affected. Currently, habitat quality throughout many parts of the lignite belt is low and wildlife populations are subject to considerable man-made disturbances. Thus, ecosystems affected by mining are already stressed.

Present reclamation practices do not favor habitat maintenance

Since existing conditions are often poor, reclamation to restore a native mix of species could result in improved habitat quality. However, current reclamation practices often feature monocultures such as Coastal Bermuda and other tame grasses planted for grazing. This kind of vegetation provides little cover and food for wildlife.

Cooling ponds may remove high quality habitat

Over much of the study region, bottom lands, rivers and stream courses provide continuous ribbons of good cover and abundant food for terrestrial wildlife

as well as aquatic species. The construction of cooling reservoirs represents a threat to wildlife based on the quality--rather than quantity--of habitat destroyed.

Many lignite-related impacts on aquatic habitats are likely to be site-specific. The most likely widespread effects would arise from increased frequency of low-flow conditions, and from the fragmentation of river habitats by reservoir construction.

Socioeconomic Impacts

Socioeconomic impacts associated with coal and lignite development are anticipated

The *spatial, temporal, regulatory* and *social* context of Texas lignite development can reduce the likelihood of serious socioeconomic problems such as those associated with the coal mining boomtowns in the Rocky Mountain West.

The current distribution of population will moderate boom-bust tendency

- *Spatial* - As illustrated in Figure 6, the lignite belt is bounded on either side by the state's two largest urban concentrations--the Gulf Coast, and the Dallas-Austin-San Antonio corridor. Within the lignite belt are numerous, rather evenly distributed small cities and towns. This pattern of development indicates that no single community will bear all the impacts resulting from large developments located in rural areas.

Lignite development will span the next two decades

- *Temporal* - The lignite development scenario projects sustained growth and increased development throughout the 1980's and 1990's rather than a large and sudden exploitation of the resource followed by the "bust" as the resource is depleted.

PSD will discourage concentrated development

- *Regulatory* - Environmental regulations--particularly the Prevention of Significant Deterioration (PSD) of air quality--will tend to discourage concentration of development. This in turn, will tend to spread the benefits as well as impacts of population growth associated with lignite mining and use.

Texans are generally receptive to continued energy development

- *Social* - The lignite belt is a region of earlier oil and gas development which has had slow economic growth and population out-migration in recent decades. As a result, much of the region's population views lignite development as economic stimulus which is simply an extension of this earlier oil and gas development.

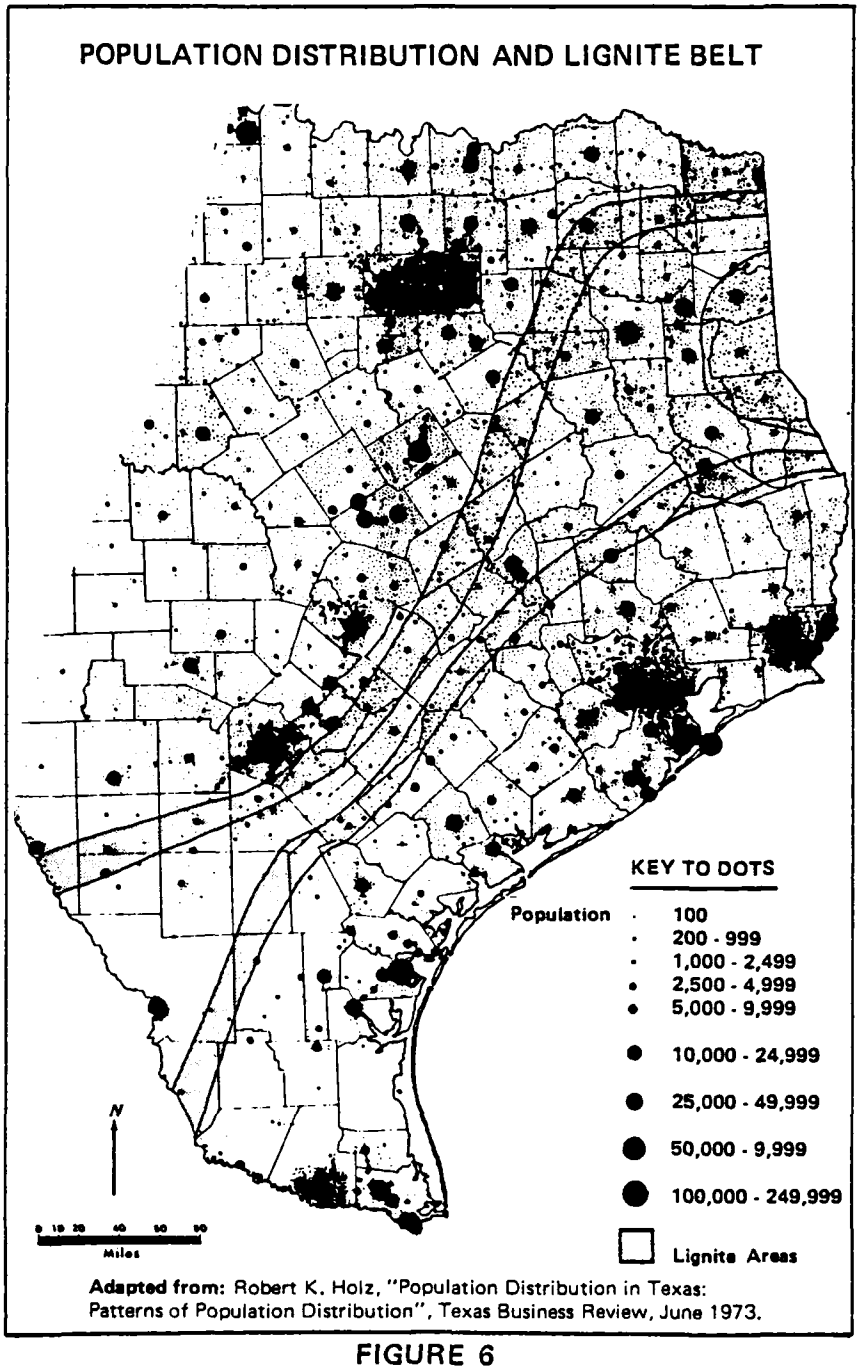


FIGURE 6

Lignite development impacts will effect housing, water and wastewater supply, public safety and fire protection, health care and education

Regardless of whether the impacts of new mines and power plants are shared among several towns or concentrated in a few communities, demand for new services and facilities will occur in the following areas:

- *Housing*--Demands are usually met by the private sector--sometimes with the proliferation of mobile homes, temporary scarcity, higher rents, and long distance commuting.

- *Water supply and wastewater*--Needs are met by the public sector which requires time for planning and may require financial assistance. Septic tanks may be a short-term solution.

- *Public safety and fire protection*--Services are provided by public sector but labor shortages may occur due to competition from energy developments.

- *Health care*--Many small towns already have difficulty attracting qualified medical professionals.

- *Education*--Captial for new schools must be raised by the public sector and new teachers hired.

Financing needed for improvements requires front-end capital

In the areas requiring a public sector response, the problem of providing front-end financing before the increased tax revenues are available is common. The problem of financing is compounded when a new facility is sited in one taxing jurisdiction and the impacts are borne by another jurisdiction. This is an equity consideration which must be addressed on a regional level.

V. POLICY ANALYSIS

Method of Analysis

The purpose of the policy analysis is to present a range of alternatives to policymakers

The policy analysis section of the full report provides a means for federal, state, and local policymakers to view a range of policy options and to select for themselves the preferred course of action. This is achieved through a presentation of the advantages and disadvantages of each policy alternative. In some cases, the alternatives are not necessarily mutually exclusive. The report does not attempt to make policy recommendations.

This task was conducted in the following steps:

18 issues are addressed

- Eighteen policy *issues* were identified based on *findings* or conclusions from the first three tasks. These 18 were selected from a larger collection identified earlier in the study.

- The principal conflicting *objectives* or value orientations were identified for each issue.

- For each objective, one or more general policy *alternatives* for achieving the objectives were identified.

- In some cases, specific *implementation* measures (i.e., changes in regulations or new legislation) to execute the alternative were identified.

Results

The policy issues dealt with in this study can be grouped into three principal categories:

Driving issues are nationally oriented

- *Driving Issues* - There are two issues which were judged to be of national character and of overriding significance to the demand for Texas lignite. These relate to the policies required with mandatory boiler fuel conversion and National Ambient Air Quality Standards for ozone. Of these two, the national policy promoting coal conversion and discouraging oil and gas use in utility and industrial boilers is the single most important issue affecting the rate and scale of lignite development.

Resource management issues are state and national questions

- *Resource Management Issues* - These are a set of issues which involve both state and federal participation and concern the management of lignite and water resources.

Response issues are primarily of local and state concern

- *Response Issues* - These issues deal primarily with the mitigation of impacts resulting from lignite development. The chief actors in this area are state and local governments.

Following is a brief outline of the findings, issues, objectives and some of the major alternatives assessed in the policy analysis task. The specific implementation alternatives and the implications are not discussed in this summary. Issues 1 and 2 are the driving issues; 3 through 7 are the resource management issues, and 8 through 18 are response issues.

1. Driving Issue: Mandatory Boiler Fuel Conversion

The impacts of mandatory boiler fuel conversion will affect Texas relatively more than other regions

The federal policy requiring the phasing out of utility use of gas and the prohibition of new utility and industrial boiler fuel use of oil and gas is the thrust of the Fuel Use Act of 1978--one of five components in the National

Energy Act. The impacts of this legislation will affect Texas and the Gulf Coast more than any other part of the nation. If this act is interpreted strictly, the resulting high levels of fuel switching may be economically and environmentally burdensome to the state. This policy will require the balancing of three distinct objectives. These objectives are:

This issue involves the balancing of three objectives:

Energy independence

- *Reduce national energy dependence on foreign sources.* The idea of energy independence dates back to the 1973 Arab oil embargo. It is still a major focus of national energy policy and was the impetus for enactment of the Fuel Use Act. Major alternatives to mandatory fuel conversion include import restrictions, enforced conservation, oil and gas price deregulation, incentives for synfuels and renewable energy development, and relaxation of air quality-related siting constraints.

Meeting clean air goals

- *Maintain clean air goals.* A major conversion to lignite and coal is likely to bring about conflicts over use of the limited clean air resource under current PSD and nonattainment policies. Long-distance transformation and transport of air pollutants could also result in deteriorated air quality outside the state. Interstate conflicts over economic growth opportunities could raise. Among the alternatives for achieving this objective are the granting of generous exemptions to mandatory fuel conversion, requiring more stringent controls for new and existing sources, and promotion of conservation and alternate energy technologies.

Continuing economic and industrial growth

- *Minimize disruption of economic growth.* Both the energy independence and air quality protection objectives can be met only at a certain cost, which is spread through the economy as a whole. This cost could be held down by relaxing either or both of these two objectives. Within the context of current laws and regulations, there are a variety of alternatives which would relax the requirements to convert (such as the granting of exemptions to provisions of the Fuel Use Act) and to protect air quality levels (such as reclassification under PSD).

Each of these three objectives is supported by powerful interest groups and each can be defended in terms

of serving the public good. For example, national security and balance of payments arguments are persuasive reasons for supporting mandatory fuel conversion. Likewise, concerns over public health, which support the objectives of clean air, and over economic growth and jobs, which support the objectives of industrial development, are equally compelling. The resolution of these conflicts will have a major effect on the level and rate of lignite development in Texas.

2. Driving Issue: Air Quality Nonattainment for Ozone

How can the state cope with ozone air quality nonattainment and continue to provide industrial growth?

Widespread violation of the National Ambient Air Quality Standard for photochemical oxidants (or ozone) threatens to constrain continued growth of the major concentrations of refining and petrochemical production in Texas. This, in turn, could reduce the demand for lignite, directly and indirectly.

The key issue is over finding ways to provide for continued growth in these sectors while progressing toward attainment of the standard. Major alternatives addressed include a change in the NAAQS, redirection of growth into clean air areas, statutory revision of the Clean Air Act, improved control technology and imposition of transportation controls to cut down on ozone precursors emitted by autos.

3. Resource Issue: Electricity Grid Interconnection

Will mandated interconnection of Texas electric utilities result in export of lignite-generated energy?

Federal policy supports interconnection of the intrastate electric utility systems. While most members of the Texas Interconnected System (TIS) believe that interconnection would increase costs and reduce reliability, other members dispute this and favor interconnection.

An issue involved in this controversy relates to the possibility that significant amounts of lignite-generated electricity will be exported out-of-state, resulting in regional equity problems. Objectives to be considered in this issue are:

- To provide for increased economies of scale and reliability for all Texas electric utilities while minimizing economic impacts on TIS members and customers

- To spread the benefits of low cost lignite-generated power to non-TIS consumers

- To minimize federal involvement in the intrastate power grid and confine the indigenous lignite resource to Texas users

4. Resource Issue: Lignite Research and Development Priorities

How can lignite R & D limitations of the near-surface lignite resource size and reduce the cost of using lignite?

Given this study's estimates of the near-surface lignite reserves and of lignite demand by electric power utilities and industry, it appears likely that almost all of the recoverable near-surface resource could be committed by the year 2000. It also appears likely that the bulk of this resource will be fired directly in combustion processes. However, coal and lignite are not now cost-effective choices for most industrial uses. The Fuel Use Act prohibits oil and gas use in new industrial boilers and could prohibit other industrial use of oil and gas. Research to reduce the costs of coal and lignite use in industry can help reduce fuel conversion costs.

Assuming that these findings are correct, the state's energy research, development and demonstration priorities should focus on three research objectives:

- To expedite the development of technologies for recovery of the lignite resource which lies at depths below the strippable range,
- To continue to identify and to mitigate barriers to the environmentally and socially acceptable recovery and use of the near-surface resource, and
- To encourage the development of technologies which will make the industrial use of lignite more economically and environmentally attractive.

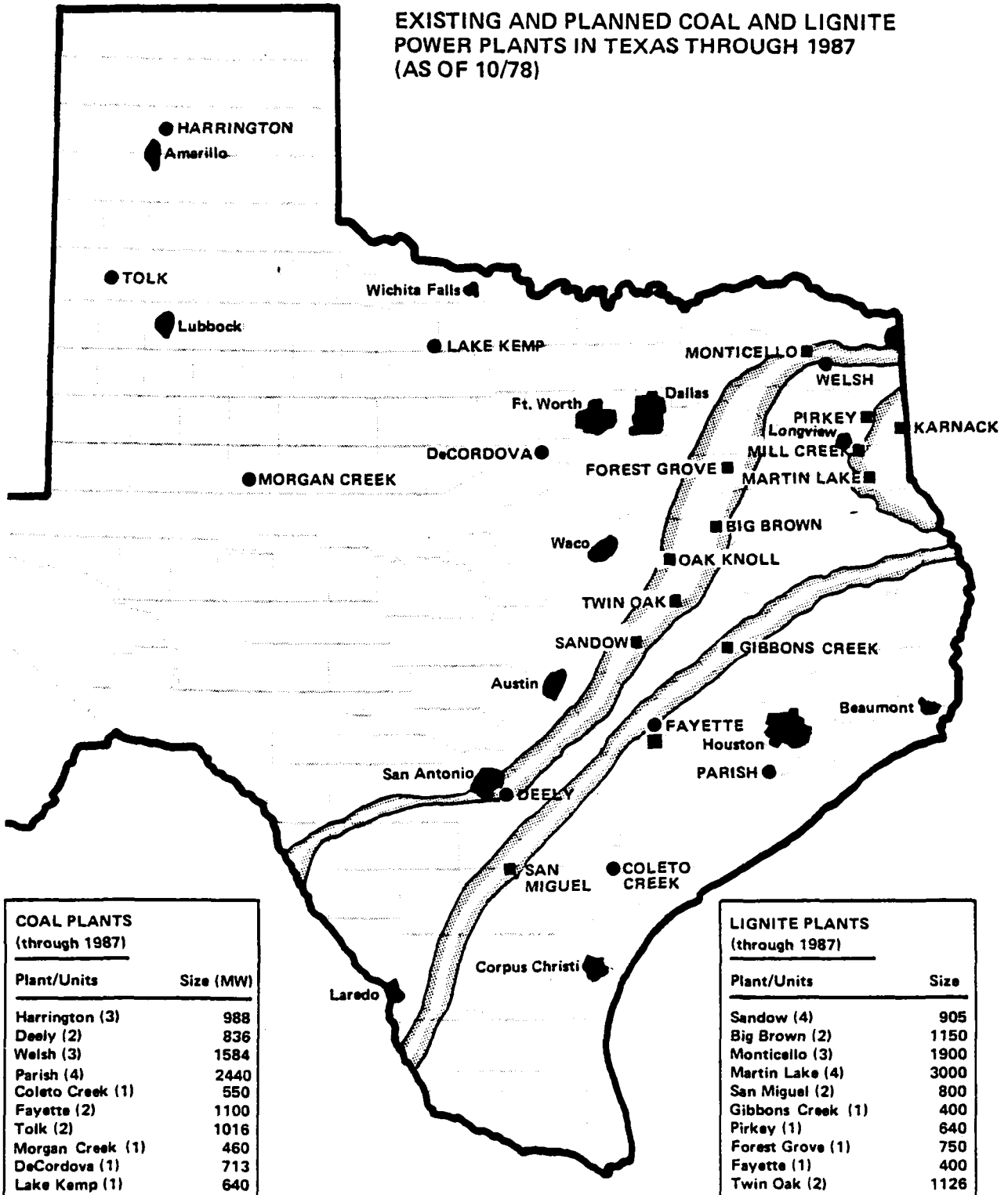
5. Resource Issue: Lignite Resource Depletion

Should the state act to discourage rapid depletion of the lignite resource?

Current projections of lignite demand together with estimates of strippable lignite resources in Texas indicate that nearly all of Texas' near-surface reserves may be committed for use by the year 2000.

This finding inevitably leads to the basic alternatives of whether it is in the best long-term interest of Texas to allow all its near-surface lignite deposits to be developed at such a rate, or whether the rate and scale of development should be managed to save part of the re-

EXISTING AND PLANNED COAL AND LIGNITE POWER PLANTS IN TEXAS THROUGH 1987 (AS OF 10/78)



COAL PLANTS (through 1987)		
Plant/Units		Size (MW)
Harrington (3)		988
Deely (2)		836
Welsh (3)		1584
Parish (4)		2440
Coleto Creek (1)		550
Fayette (2)		1100
Tolk (2)		1016
Morgan Creek (1)		460
DeCordova (1)		713
Lake Kemp (1)		640
Others:		
Site Unnanounced (2)		400
TOTALS	(22)	10,727

LIGNITE PLANTS (through 1987)		
Plant/Units		Size
Sandow (4)		905
Big Brown (2)		1150
Monticello (3)		1900
Martin Lake (4)		3000
San Miguel (2)		800
Gibbons Creek (1)		400
Pirkey (1)		640
Forest Grove (1)		750
Fayette (1)		400
Twin Oak (2)		1126
Karnack (1)		640
Mill Creek (2)		1500
Oak Knoll (1)		750
Others:		
Site Unannounced (2)		1500
TOTALS	(27)	15,461

FIGURE 7

source for use in advanced technologies such as a synfuels feedstock. Protection against early depletion might also insure a more economic or attractive long-term fuel mix, rather than converting now to lignite and then having to rely entirely on more expensive fuels later.

6. Resource Issue: Water Supply

How can water development and allocation insure adequate supplies for lignite while mitigating conflicts among users?

It was determined that adequate water supplies would be available for lignite development, if development and allocation of water resources are properly managed. The issue is how to coordinate the development and allocation of water resources to insure supplies for lignite development while mitigating the inevitable conflicts among competing users.

Three basic alternatives for insuring sufficient water supplies for use in lignite development are:

- To develop additional supplies through the construction of new reservoirs;
- To allocate existing water resources more efficiently among competing users; and
- To conserve water through improved efficiency of use, both for lignite and for other uses.

7. Resource Issue: Power Plant Cooling

What are the most appropriate power plant cooling techniques?

A major issue relating to water availability and quality involves power plant cooling technology. There are several methods of power plant cooling. The choice of which method to employ is a point of sharp controversy in Texas. Power plant cooling alternatives are:

- To control fresh water consumption in the cooling process through use of dry cooling towers or through siting along the Gulf Coast.
- To increase siting flexibility and minimize costs through continued use of cooling ponds.
- To eliminate thermal discharges by requiring cooling towers.

8. Resource Issue: State Surface Mining Approval

How should the state maintain regulatory jurisdiction over surface mining?

An immediate issue before the state legislature is the problem of redrafting the state surface mining statute to comply with federal statute. The objective of the state is to continue to maintain exclusive jurisdiction over surface mining. Many lignite developers fear that assumption of this program by the federal government will lead to significant delays and uncertainties in the permitting process, thus increasing costs and reducing production. A variety of alternatives are available to achieve this objective.

9. Resource Issue: Designation of "Lands Unsuitable" for Surface Mining

What criteria should the state use for designating lands unsuitable for mining?

Several hundred thousand acres of the state will be disturbed by surface mining operations to recover lignite between now and 2000. Although the process of mining and reclamation will be sequential (thus mitigating the cumulative impact), there is a potential for the loss of certain environmentally sensitive areas. Under the state's surface mining and reclamation act and proposed federal regulations, the Railroad Commission may make designations of areas unsuitable for mining.

At issue is what criteria the state should use to delineate areas unsuitable for mining.

The objective is to protect critical environmentally sensitive areas from permanent damage without unduly interfering with the economic recovery of lignite.

10. Response Issue: Ecological Impacts of Mining

How can landowners be encouraged to improve habitat of reclaimed areas?

Habitat conditions over much of the lignite belt are poor for wildlife and could actually be improved by reclamation. At the same time, there is a large and growing demand for outdoor recreational opportunities easily accessible to residents of the metropolitan areas on either side of the lignite belt. Currently, ecosystem quality is not highly valued by landowners in general. Experience to date suggests a preference on the part of many landowners to have their land reclaimed with monocultures of cultivated forage grasses.

The issue is whether and how incentives can be developed that will encourage landowners to include wildlife values in post-mining land use.

The two principal objectives are to prevent degradation of wildlife habitat after mining and to provide, if possible, additional wildlife-related recreational opportunities. A variety of incentives are explored such as strict enforcement of surface-mining regulations and providing tax incentives to reclaim lands for habitat.

11. Response Issue: Solid Waste

Can groundwater be protected from contamination without inhibiting lignite development?

Considerable volumes of solid waste will result from combustion of lignite in Texas most of which will be disposed of in surface impoundments. Because of the coincidence of the majority of lignite deposits with the Carrizo-Wilcox aquifer, there is a potential for disposal in areas where groundwater resources could be contaminated if not done properly. The chemical composition of the wastes may result in its classification as hazardous under RCRA, making it subject to hazardous waste regulations of EPA.

The issue is over appropriate requirements of state and federal regulations in protecting aquifers from contamination without severely inhibiting industry's flexibility in developing economic means of disposal.

The primary objective is the protection of aquifers while minimizing the costs of disposal. Some of the alternatives assessed include mine disposal, recycling, classification of wastes as non-hazardous, revision of air quality regulations to avoid full scrubbing, and pre-disposal waste treatment.

12. Response Issue: State Agency Permitting Review

Should the state establish a formal mechanism for coordinating energy facility siting?

Several state agencies have statutory responsibility relating to the siting of lignite mines and associated power plants. Each is concerned only with the impact(s) relating specifically to its jurisdiction. Currently, there is no formal governmental mechanism for coordinating these decisions.

The issue is whether the state should establish a formal mechanism for coordinating siting decisions relating to coal/lignite power plants.

The primary objectives are:

- To reduce permitting delays, jurisdictional conflicts and the uncertainties and costs of permitting, and

- To insure that all significant impacts are addressed and that public participation occurs in the permitting process.

The alternatives range from a new siting authority to simple coordinating mechanisms using the existing institutional arrangement.

13. Response Issue: Stream Flow Reduction and Water Quality

Will the current institutional system result in coordinated management of water quality and water use?

Consumptive water use related to lignite development can reduce in-stream flows, resulting in lowered assimilative capacity and increased dissolved solid levels. The problem is not severe, however, and potentially can be prevented by coordinating the management of water use and water quality.

The issue is whether or not the current institutional system permits such coordinated water management.

The primary objectives are the preservation of water quality and the fair allocation of costs between wastewater dischargers and water consumers. Alternatives include basin-wide coordinated planning, better monitoring programs, and changing low-flow averaging rules.

14. Response Issue: Control of Atmospheric Sulfates

How should government respond in the face of uncertainties associated with sulfate formation and acid rain?

Sulfates from coal and lignite combustion potentially have adverse effects on health and visibility. Sulfate formation is a strong contributor to acid rain. However, too little is known about these phenomena either to define an impact-related ambient standard or control strategy that can be tied to meeting such a standard.

Faced with uncertainty, both in how to regulate sulfates and in how much to regulate them, the issue is whether a policy of risk minimization should be adopted or an attempt made to establish an acceptable level of risk.

Two alternative objectives are:

- To reduce sulfate levels in the ambient air below the most conservative estimate of health hazard, using an alternative such as immediately setting sulfate standards, and

- To determine an acceptable level and define control strategies prior to setting standards, so as to avoid over-regulation.

15. Response Issue: Lignite Belt Regional Development

Will inequities result from the regional lignite development pattern?

The most probable developmental pattern for Texas lignite involves the siting of numerous mine-mouth electric generating plants along the lignite belt which will transmit power to the large urbanized areas on either side of the lignite belt.

The issue is whether this pattern of development and use will result in inequities of economic opportunity and disproportionate environmental and social impacts without corresponding long-term benefits to the producing region.

The primary objective is to equitably spread the costs and benefits of the production and use of the lignite resource between producing and consuming regions within the state. Alternatives include diversifying development, having utilities pay impact mitigation costs, or having mitigation costs paid by the state or federal government.

16. Response Issue: Infrastructural Financing

Lignite mining and mine-mouth power plant construction will continue to cause temporary and site-specific shortages of local government services and facilities. The problems of providing adequate services and facilities involves issues of timing and equity. Two objectives emerge from this finding:

How can local governments be provided with adequate and timely financial assistance?

- To provide the needed services and facilities when the need arises rather than waiting until the revenues are available.

- To provide the local jurisdiction which must finance the additional services and facilities with revenues proportionate to the demand.

Many general alternatives and specific implementation options are available for achieving these objectives, involving alterations in the methods of taxation, the means of distributing revenues, and alternatives to the present delivery of government services.

What measures are available to reduce boom and bust tendencies?

17. Response Issue: Boom-and-Bust Cycle

Without proper planning, a local area near a lignite mine and associated power plant may undergo a sudden spurt of economic and population growth followed by sharp decline as the construction of the facility is completed.

The issue is over how to reduce the severity of the boom-and-bust cycle.

The impacts task concluded that the likelihood of the boom-and-bust phenomenon in the lignite belt is small. Nevertheless, it could occur in some areas and a variety of preventative and mitigation alternatives exist.

18. Response Issue: Aesthetics and Attitudes Towards Growth

How can the aesthetic concerns related to lignite development be addressed?

Lignite-related growth will alter the appearance of the landscape both directly (mining and use of lignite) and indirectly (residential and commercial development). Although there are many individuals who feel that this activity will cause visual blight and erode the overall quality of life in the lignite belt, most Texans appear to be relatively more receptive to growth and its consequences than is the nation as a whole.

The issue is how and if these primarily aesthetic concerns should be addressed.

The three objectives related to this issue are the following:

- To reduce visual blight associated with haphazard secondary development.
- To preserve selected areas from development in order to retain and enhance character of landscape.
- To maximize the distribution of the economic benefits of lignite-related development in order to minimize antagonistic local attitudes toward growth.

VI. FUTURE RESEARCH AND INFORMATION NEEDS

One of the purposes of this study was to identify future research and information needs. These are listed below:

Lignite-Related Technologies:

- Develop improved extraction techniques that lower the cost of mining lignite and thus extend the lignite reserve.

- In-situ gasification: improved product quality, burn control; assessment of environmental impacts; techniques to control subsurface pollution problems; combustion technology adapted to use with in-situ gasification.

- Economic and engineering feasibility and environmental consequences of lignite-based industrial parks based on cogeneration and/or gasification for fuel and feedstocks.

- Identify and develop process improvements that lower capital costs and reduce the environmental impacts of aboveground lignite combustion and gasification technologies, improving their commercialization potential.

- Study feasibility of state options for providing incentives through taxation and utility rate-setting for new technology introduction.

Lignite Supply and Demand:

- How is the amount of economically recoverable lignite related to price?

- How might Mexican oil and gas discoveries affect the energy mix in Texas? What are the potential effects on lignite demand?

- How might interconnection of Texas electric utilities with grids in adjacent states affect lignite demand?

Industrial Lignite Use

- Characterize possible future industrial mixes in Texas and their fuel demand patterns. What factors drive industrial development? How can the state influence the resulting mix?

- Identify future trends in industrial siting. How do these trends affect potential lignite use? How does lignite affect industrial siting?

- Given existing energy, environmental and economic policies, how will industry respond regarding fuel selection?

- How might industry and utilities compete for limited supplies of lignite? Does the resulting distribution allocate lignite to uses which produce the greatest return to the state's economy?

Constraints on Lignite Development

- Develop an improved method of estimating water available for energy development. What potential conflicts exist among users and what can be their economic effects? What measures can be taken to reduce or avoid these results?

- Inventory lands that might be declared unsuitable for mining under the Surface Mining Act. Could such designations reduce the amount of lignite economically mineable?

- What options exist to allocate PSD increments through economic means, such as marketable permits? Could such methods increase the amount of lignite use possible at the mine-mouth? Compare the economic effects of these methods with first-come-first-serve permitting.

- Develop improved models for air quality impacts of multiple sources throughout the lignite belt. What spacing patterns are necessary to meet PSD and ambient air quality standards?

- Inventory the status of PSD increments throughout the state. Is mine-mouth siting of lignite-fired facilities likely to be restricted?

Impacts of Lignite Development

- Develop models of sulfate and ozone formation downwind of lignite-fired power plants. Evaluate potential long-distance transport and its effects. Could mine-mouth siting of lignite-fired facilities be restricted?

- Characterize possible ranges of radioactive emissions and trace element emissions from lignite burning. Might special control measures be needed if federal emission standards are imposed?

- For major river basins, model potential reductions in waste assimilative capacity resulting from consumptive water use for energy development. What changes in management are needed to counteract these effects?

- Characterize solid wastes from Texas lignites. What disposal options are available for these wastes? How are these options affected by developing federal regulations? How do disposal costs for lignite wastes compare with those of coal?

- Characterize in detail the potential subregional-level socioeconomic impacts of growth in the lignite belt. What new services are needed and how might the costs be spread? What planning problems occur at this level and what groups might take responsibility for planning?

- Evaluate the use of a severance tax on lignite as a source of revenue for offsetting impacts of mining and use. What level of tax would provide revenue without raising prices enough to reduce lignite use? How might such revenues be distributed?