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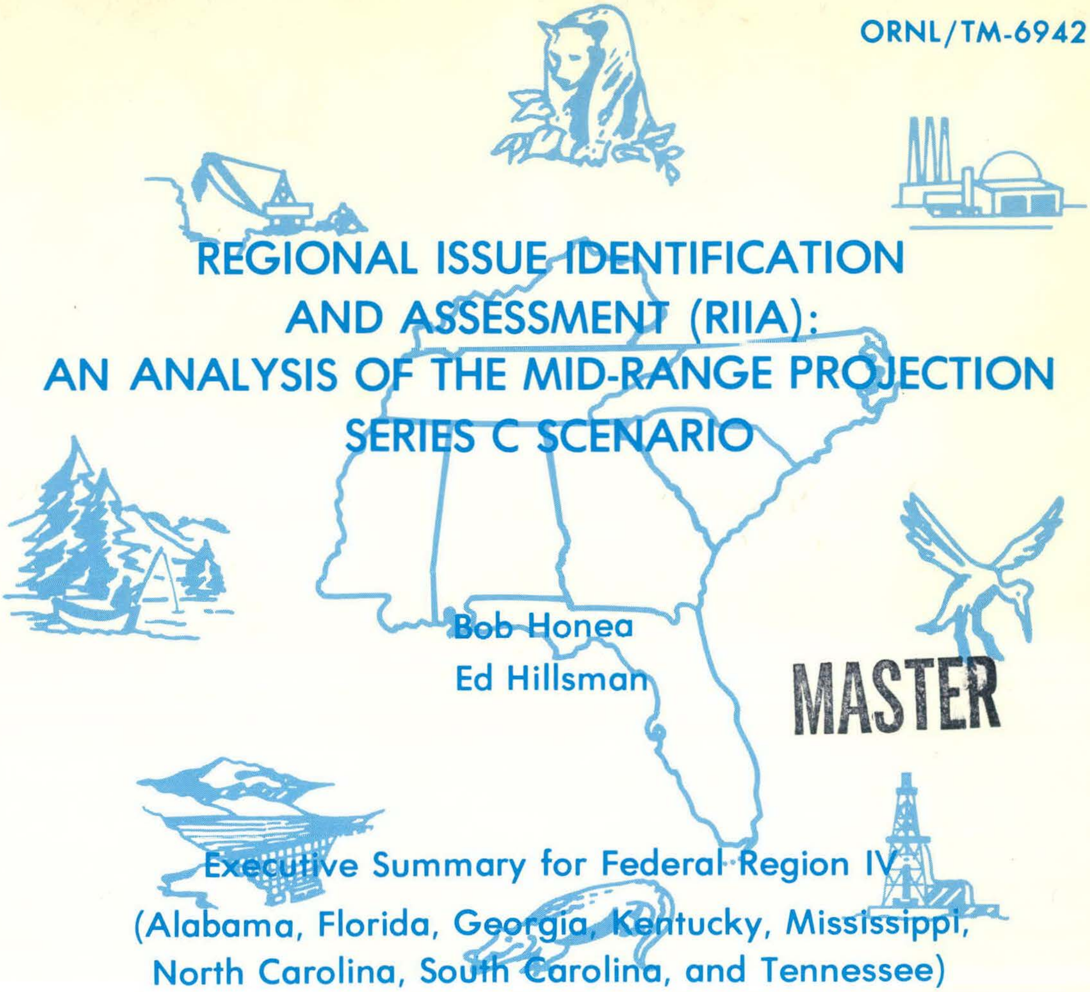

REGIONAL ISSUE IDENTIFICATION AND ASSESSMENT (RIIA): AN ANALYSIS OF THE MID-RANGE PROJECTION SERIES C SCENARIO

Bob Honea
Ed Hillsman

MASTER

Executive Summary for Federal Region IV
(Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee)

ORNL REGIONAL STUDIES PROGRAM

OAK RIDGE NATIONAL LABORATORY
OPERATED BY UNION CARBIDE CORPORATION · FOR THE DEPARTMENT OF ENERGY

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Executive Summary for Federal Region IV
(Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee)

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The following is a list of related reports completed at ORNL. Copies are available from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

Title	Author(s)	Document Number	Date
Energy Conditions in the South, 1975	P. L. Rice	ORNL/TM-5568	1976
The Maryland Power Plant Siting Project: An Application of the ORNL Land Use Screening Procedure	J. E. Dobson	ORNL/NUREG/TM-79	1977
A Cell-Based Land Use Screening Procedure for Regional Siting Analysis	J. S. Jalbert J. E. Dobson	ORNL/NUREG/TM-80	1977
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A System for Regional Analysis of Water Availability	J. S. Jalbert A. D. Shepherd	ORNL/NUREG/TM-82	1977
Coal and Energy: A Southern Perspective — Regional Characterization Report for the National Coal Utilization Assessment	F. D. Boercker et al.	ORNL/TM-5900	1977
Nationwide Assessment of Water Quantity Impacts of the National Energy Plan, Volume I, Summary and Conclusions	J. E. Dobson et al.	ORNL/TM-6098	1977
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Water Availability Problems for Energy Development to 1990	J. E. Dobson A. D. Shepherd	ORNL/TM-6777	1979
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ABSTRACT

The Department of Energy (DOE) has hypothesized a number of alternate energy futures as part of its energy planning and analysis programs. In this report, which is part of DOE's Regional Issue Identification and Assessment (RIIA) Program, Oak Ridge National Laboratory examines how a proposed energy future called the Mid-Range Projection Series C Scenario would affect Federal Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee).

This scenario, to be called the Series C Scenario, assumes a medium supply and a medium demand for fuel through 1990, and it incorporates the fuel switching provisions of the Energy Supply and Environmental Coordination Act.

The report portrays the major regional environmental, human health and safety, socioeconomic, and institutional effects that might result from the implementation of the Series C Scenario. This discussion should serve as a basis for further assessments, as it identifies some issues of major concern for Region IV that must be addressed.

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KEY FINDINGS FOR FEDERAL REGION IV

The majority of issues are longstanding and would exist within any energy future. However, a few of the issues, particularly those related to the coal fuel cycle, would probably be aggravated by the Series C Scenario because of its projections for increased use of coal in the future.

- In the Southeast, institutional and political issues are not expected to restrain electrical energy production. Much of the region's future electrical energy is projected to come from nuclear power (approximately 20% by 1985); the effect of the accident at Three Mile Island on future nuclear construction in the region is unknown.

- Southern Florida is projected to have severe water shortages during low-flow periods by 1985 because of extensive irrigation and urban usage. Any further increase in water consumption is likely to conflict with current needs.

- The Southeast may be constrained in its energy development as a result of potential shortages of skilled manpower. (The Scenario requires a 36% increase in the need for skilled manpower by 1990.) The region may also face problems with capital availability (30% increase by 1990).

- The risk to human health from exposure to fossil fuel combustion products will be significant in Kentucky, Tennessee, Alabama, Georgia, and North Carolina by 1990. This exposure will be aggravated by increased combustion of coal to the west, upwind of Region IV.

- Deaths from underground coal mining, particularly in Kentucky, will increase significantly by 1990 (possibly to as high as 4000 per year).

- Problems of solid waste management (from surface mining and scrubber sludges) are not expected to restrain energy development in the Southeast by 1990.

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CONCLUSIONS

The Regional Issue

The underlying issue concerning energy growth and development in the Southeast is the perceived relationship between energy and economic growth. The region is concerned with more than just the availability of energy, as addressed by the Mid-Range Projection Series C Scenario; it is also concerned with the region's economic competitiveness and its share of the national economy. The economy of the Southeast still lags behind the nation. Thus, any energy or environmental policy that reduces the region's potential for closing this economic gap is of major importance.

For example, projections for increased use of coal, as specified under the scenario, would make compliance with the Air Quality Amendments of 1977 and the Resource Conservation and Recovery Act more difficult for industry and utilities. Many believe that the Prevention of Significant Deterioration (PSD) and nonattainment provisions of the amendments could stifle much future economic growth in sections of the Southeast that already have high pollution levels. As another example, the scenario reflects the provisions of the Energy Supply and Environmental Coordination Act (ESECA) of 1976. These provisions call for a major switch of fuel use in utilities and industry from oil and gas to coal by 1985. Because parts of the Southeast are highly dependent on oil and gas, major capital and infrastructure investments will be required to comply with this fuel switching policy. The cost of installing coal-fired boilers in these utilities and industries and the cost of establishing adequate coal transportation and distribution lines into the region will increase operating costs in the region. This increased cost will likely be borne disproportionately by the Southeast and may make the region's economy less competitive with the rest of the nation. These and other coal related issues are already apparent in the region. However, the energy fuel mix patterns specified in the scenario would increase the severity of these issues in the future.

State and Local Issues

In the discussion for individual states, the majority of issues identified in the region are long-standing and would exist in any particular energy future. However, a few of the issues, particularly those related to the coal fuel cycle, will probably be aggravated by the increased use of coal in the future as required in Mid-Range Scenario projections. For example, the state of the region's coal transportation system has been of concern in several coal mining states for some time. Many air quality problems projected for the region's urban areas under the scenario assumptions already exist and will worsen in the future. Other major issues identified in each state are summarized below.

- Increased combustion of coal in Alabama will have adverse effects on public health, and possibly vegetation in parts of the state. The projected switch from surface mining to deep mining will increase coal mining injuries and deaths (from 170 in 1975 to an estimated 620 in 1990). With these exceptions, Alabama should have few problems in accommodating the changes projected by the Mid-Range Scenario.

- The availability of water may limit the energy developments projected by the scenario in southern Florida and along the Gulf coast of the peninsula. The increased use of coal in Florida may strain the state's transportation system, increase the risk of groundwater contamination, and, in central Florida, reduce yields of fruit and vegetables.

- New utility construction in southern Georgia will have significant socioeconomic impact upon five rural counties. Water availability in the headwater streams near Atlanta may limit urban and energy water consumption in the Atlanta area. Otherwise, the scenario's projections will have little significant impact on Georgia.

- The increased coal mining and combustion projected for Region IV will have the greatest impact on Kentucky, the nation's leading coal producer. Other states in the region may suffer severe impacts in one or two categories, but Kentucky will bear severe impacts in most categories. Current problems in the transportation of coal by truck will worsen. Five rural counties will experience significant socioeconomic impacts from the construction of new coal-fired power plants. Surface mining of coal will cause local water quality problems in parts of the upper Ohio basin. Air quality problems will persist in much of the state, and these problems will severely affect crops in western Kentucky. Mining accidents and diseases will claim more lives in Kentucky than in any other state in the region.

- Two counties in Mississippi are likely to suffer considerable socioeconomic impacts from power plant construction, and vegetation in one county may be adversely affected by SO_2 emissions. Increased coal use in the state will raise the risk of groundwater contamination. With these exceptions, the scenario should have only low or moderate impacts on Mississippi.

- Eastern North Carolina may experience low-flow water supply problems under the conditions the scenario foresees, and local water shortages are possible elsewhere in the state. One county is expected to experience significant socioeconomic impacts. Air quality will be a problem in the western and Piedmont areas, possibly affecting vegetation there.

- South Carolina should experience little difficulty under the scenario's conditions. One county will experience high socio-economic impacts from nuclear plant construction, and the uncertainty over nuclear power may delay construction of the nuclear generating stations projected for the state.

- Tennessee's coal transportation system may be strained by projected increases in coal production, and four rural counties in the state should experience significant socioeconomic impacts from power plant construction. Coal mining has and will continue to affect water quality in some local areas. Air quality will continue to be a problem in the state's metropolitan areas, despite increased reliance on nuclear power, and exposure to the products of fossil fuel combustion may cause 230-4800 deaths per year.

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The extraordinary efforts of ORNL secretaries Alice Clayton, Ruth Friar, and Bonnie Brummitt, and the editorial support of the ORNL Technical Publications staff also deserve a special expression of gratitude.

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LIST OF TABLES

1. INTRODUCTION

1.1 RIIA Study Description

This study, the Regional Issue Identification and Assessment (RIIA), is an evaluation of the regional environmental impacts of future energy development. The study was conducted for the Regional Assessments Division, Office of Technology Impacts, Office of the Assistant Secretary for Environment, Department of Energy (DOE). The impacts described for 1985 and 1990 are based on a national energy projection (scenario) that assumes medium energy demand and medium fuel supply through 1990 but does not incorporate the policies of the National Energy Act (NEA). The scenario, variously known as the Mid-Range Projection Series C Scenario, or simply the Series C Scenario, is one of six possible energy futures produced by the Energy Information Administration of the Department of Energy for the Department's 1977 Annual Report to Congress. It was chosen as representative of the official DOE national energy projections when this project was initiated, prior to the passage of the NEA. Because the RIIA program is part of an ongoing review of the regional impact of energy policies, the next phase will examine the NEA and initiatives suggested by the President's second National Energy Plan. However, because coal utilization increases generally under the NEA, in general, impacts identified in the Series C Scenario should provide a framework for the discussion of impacts by NEA.

The environmental impacts discussed in this volume are for Federal Region IV. There are nine companion volumes — one for each federal region in the nation (shown in Fig. 1.1). This set of reports represents a comprehensive, consistent portrayal of the regional environmental impacts and implications of the future national energy development reflected in the scenario. A detailed description of the methodologies used at each level of this study and a summary of the data developed in the RIIA process for each state are available in Volume II of the national report.

1.2 RIIA Methodology and Technology Control Assumptions

1.2.1 Overall program methodology

In developing the national energy scenarios, the Energy Information Administration balances projections of supply and demand at the federal region level. The RIIA studies used the predicted fuel mixes by federal regions derived from the Mid-Range Projection Series C Scenario as a starting point for their analyses. County level patterns for utility, industry, and mining activities for 1985 and 1990 were then developed from these federal region totals. Energy sources addressed were coal, nuclear, oil, oil shale, gas, geothermal, hydroelectric, and solar.

Six of the DOE national laboratories — Argonne (ANL), Brookhaven (BNL), Lawrence Berkeley (LBL), Los Alamos (LASL), Oak Ridge (ORNL), and Pacific

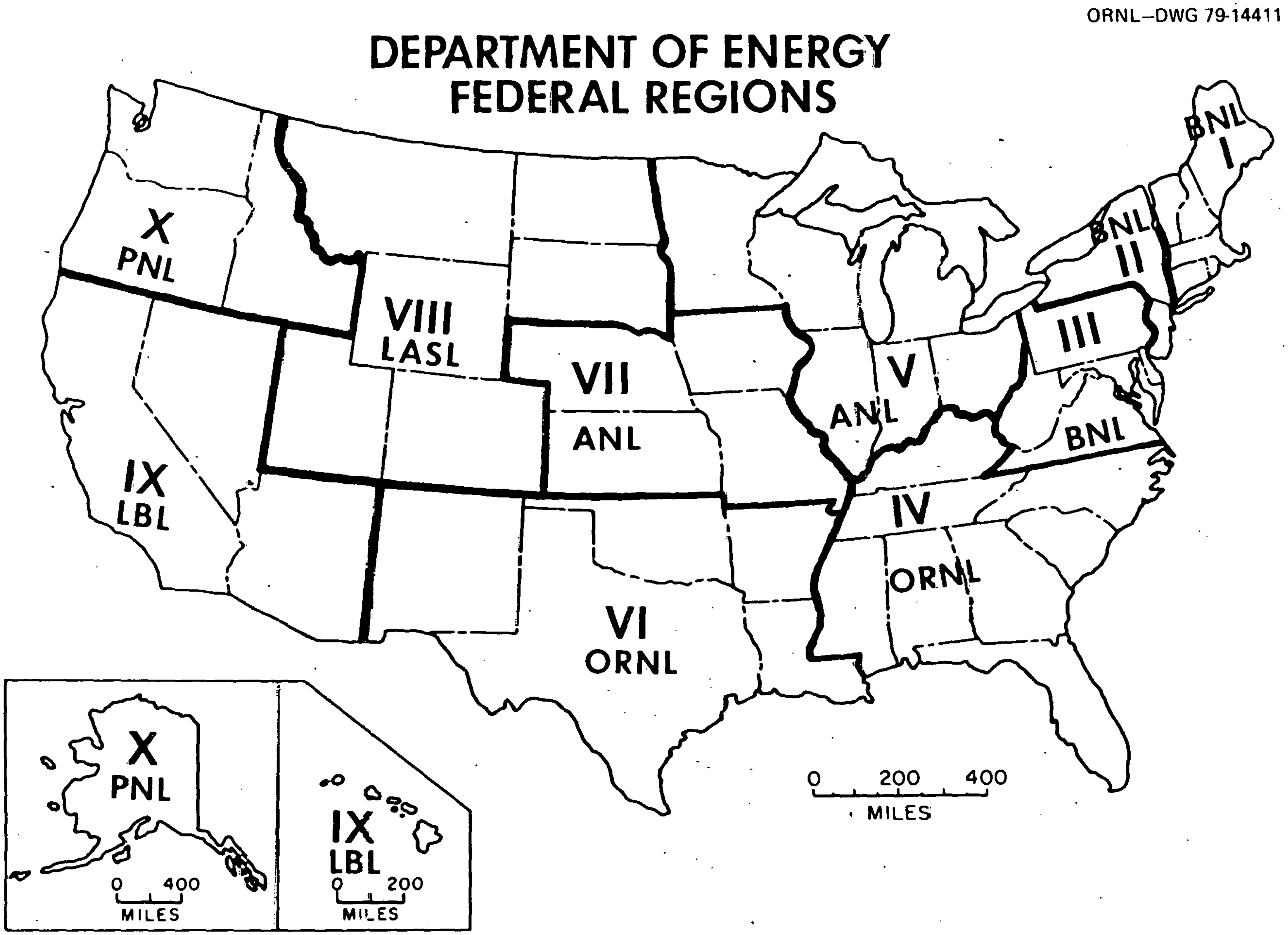

Fig. 1.1. Federal regions assigned to each national laboratory.

Northwest (PNL) — assumed various lead assignments in analyzing the impact of these county level patterns on the air, water, and land resources of the country and on the socioeconomic and health and safety aspects of the nation's welfare. When these tasks were complete, each laboratory focused on an assessment of the products of all the lead laboratory analyses from the particular perspective of the states and regions for which they were responsible (Fig. 1.1).

1.2.2 Technology assumptions

The major control technology assumptions used in the lead analyses of technologies addressed in the scenario concerned control techniques. These are shown in Table 1.1. In addition to those listed, other more specific technology assumptions were made in some of the regional assessments of areas or states when energy production and distribution differed significantly from national trends. These exceptions are specifically identified in the text when appropriate.

1.2.3 Critera for ranking of impacts

The discussion of each region and each state within the region includes a summary matrix displaying the severity of specific environmental, health, social, and economic impacts of energy and energy technologies imposed by the scenario. The severity is rated as high, medium or low according to criteria described in Table 1.2. Because of the inappropriateness of some impact criteria for the Southeastern Region, ORNL chose to modify the severity ratings in selected categories.

Water quality. The suggested criterion for "high" impact — "significant economic burden to meet Clean Water Act (CWA) requirements" — calls for an assessment of the economic impacts of the CWA regulations, the suggested "medium" and "low" criteria describe the levels of actual water quality impacts projected for the scenario levels of development. To avoid inconsistencies that might arise from using a purely economic criterion for only one level of one type of impacts, we have expanded the definition of "high" impact. In our analysis, "high" impact indicates river basins where new, widespread violations of water quality standards attributable to energy facilities have been predicted at scenario levels of development.

In some areas, flows (and thus the assimilation and dilution capacities) are so low that the national model assumed no discharges of utility and industrial effluents. These areas have been given a "high, flow-related (HF)" classification. It is in these areas that the suggested criterion of economic burden is most likely to apply. In river basins where energy facilities will add to existing water quality violations, but cause no new ones, a "medium" rating has been used.

Table 1.1. Control technology assumptions[a]

Air

Utility

Emissions and local air quality

Coal

- Existing plants — uncontrolled emissions based on FPC coal characteristics for ash, heat, and sulfur (1976).
- Plants with startup dates prior to 1983 — SIPs or NSPS requirements
- Plants with startup dates after 1983 — BACT. 85 and 90% control or removal of SO_2 considered

Oil

- SIPs requirements

Gas and metallurgical coal

- Uncontrolled

Industry

Emissions and local air quality

Coal	SO_2	Particulates
New large sources (>250 × 10^6 Btu/hr)	BACTEA, 80% removal (1.5 lb/10^6 Btu)	BACTEA, 99% removal (0.05 lb/10^6 Btu)
New small sources (100–250 × 10^6 Btu/hr)		
New non-MFBI plants (>100 × 10^6 Btu/hr)	SIPs with physical cleaning	SIPs, cyclones
Existing large sources (>250 × 10^6 Btu)	SIPs for MFBIs	SIPs for MFBIs
Existing small sources (100–250 × 10^6 Btu/hr)	SIPs for MFBIs	SIPs for MFBIs
Existing non-MFBI plants (>100 × 10^6 Btu/hr)	SIPs using locally available coal	SIPs using settling chamber, expanded chimney, and cyclones

Oil and gas

- SIPs limitations on sulfur content of fuel, as a weight fraction
- Emissions factors in EPA "Compilations of Air Pollutant Factors."

BPCT, effective July 1977

BACTEA, effective July 1984

NSPS, effective July 1977

Mining

No assumptions made.

Air pollutants from mining activities not considered.

Water quality

Utility

BPCT, effective July 1977

BACTEA, effective July 1984

NSPS, effective July 1977

Utility generating load factor — 55%

Mining

Mine drainings: CSR drainage data base. Compliance with effluent limitations assumed.

Coal washing: Assume 50% of coal is cleaned, 96% of of that by wet methods. All facilities have zero discharge in CSRs 7–10; 60% of facilities have zero discharge in CSRs 1–6, CSR 11, and CSR 12. 40% of facilities in those CSRs produce 2150 liters per metric ton of coal washed.

Coal refuse pile: 40% of annual precipitation in each CSR results in effluent runoff: 7.08 × 10^{6} hectares per metric ton of coal cleaned are exposed to rain for one year.

Reclamation: Sedimentation can achieve 80% control efficiency. Other runoff rates are from EPA National Assessment of Non-Point Source Pollution.

Water availability

Utility

Cooling option	Nuclear (1000 MW), Mgd		Fossil (1000 MW), Mgd	
	Withdrawal	Consumption	Withdrawal	Consumption
Once-through	1400.0	4	830.0	3
Pond or canal	42.0	26	25.0	15
Wet cooling tower	28.0	17	17.0	10
Dry cooling tower	0.3	0	0.2	0

Industry

Data base

- Water consumption data developed for the Water Resources Council.

Mining

Water requirements for coal extraction and washing, dust control, and revegetation are assumed to be negligible.

Solid waste

Utility

- Coal characteristics in 1985 and 1990 the same as in 1976. Data from FPC tapes.
- Use of electrostatic precipitators and flue gas desulfurization with lime/limestone slurries for 1985 and 1990.

Industry

- NSPS and SIPs requirements used to determine ash and FGD sludge production and land requirements.

Mining

Conversion factors for coal mining ranged from 0.0818 acres per 1000 tons of coal mined in deep mining in Eastern Kentucky to 0.235 acres per 1000 tons in strip mining in Arkansas.

Past Bureau of Mines data and MINERS program were used to determine mining residuals.

[a]Abbreviations: BACTEA, Best Available Control Technology Economically Achievable; BPCT, Best Practicable Control Technology; Btu, British Thermal Unit; CSR, Coal Supply Region; EPA, Environmental Protection Agency; FGD, Flue Gas Desulfurization; FPC, Federal Power Commission; MFBI, Major Fuel Burning Installations; Mgd, Million gallons per day; MW, Megawatts; NSPS, New Source Performance Standards; SIPs, State Implementation Plans.

Table 1.2. Definitions of criteria for rating of impacts[a]

Impact category	High impact	Medium impact	Low impact
Air quality	Major facilities in proposed siting scenario possibly constrained by one or all of the following issues: • Persistent and continued violations of primary NAAQS • Inability to attain acceptable PSD increment limitations • Limited probability that improved emission control efficiencies or offsets would result in NAAQS attainment	Some major facilities in proposed siting scenario possibly constrained by high impact issues Violations occurring, but amenable to extensive control technology, fuel (coal and oil) purchasing policy, and/or offset	Air quality and emission levels within acceptable standards No major adjustments to plant siting
Visibility[b]	Significant decrease in calculated visual range in Class I areas	Moderate decrease in visual range, but amenable to mitigation measures	No decrease in visual range; new siting impacts amenable to mitigation measures No major adjustment in plant siting
Water Quality[b]	Significant economic burden to meet requirements of Clean Water Act	Treated effluents meeting effluent standards, but occasional localized stream standard violations to occur in receiving water body	Receiving body capable of handling all projected effluent additions Few or no violations of stream standards anticipated
Water availability[b]	No water available without major shifts in current water uses (e.g., either energy development or agriculture, even with low-flow augmentation) Water available through major structural and nonstructural alternatives (e.g., construction of dams and reservoirs) Groundwater mining with no recharge potential	Water available at moderate economic cost to the region Groundwater mining with recharge potential available or possible	No conflicts, except for recreational uses Groundwater withdrawal where annual recharge occurs
Solid waste	Severe potential contamination problems likely to require complete containment of wastes	Minimal environmental impacts with proper control technology. Indication that many areas may experience problems, but suitable options available in some of these areas	Minimal environmental impacts with proper control technologies Some potential problems, but generally amenable to current technology options at additional cost
Ecology[b]	Disturbance of critical natural habitats	Disturbance of critical natural habitat or large acreages of cropland	Localized impacts which may be readily mitigated by structural or siting alternatives
Land use[b]	Conflict with high value land use, such as loss of habitat, parkland, scenic resources, Indian lands, agricultural land	Similar conflicts, with alternative sites or mitigation measures costly but available	Few conflicts; or a range of alternatives available
Public health[b]	Significant increases in morbidity and mortality rate due to exposure to energy-related pollutants	Moderate increases in morbidity and mortality rate due to exposure to energy-related pollutants	No significant impact All impacts subject to mitigation
Occupational health and safety[b]	Significant increases in occupationally related deaths, injuries, and disease due to increased energy development	Potential significant increases in respiratory and other diseases, but improvements in OSHA, NRC and EPA regulations and workplace conditions expected to alleviate much of the problem	No significant increases in occupationally related deaths, injuries, and disease due to increased energy development
Local sociological factors	Implementation delayed or possibly blocked due to potentially severe changes in a community's quality of life Heavy demands placed on physical infrastructure including services, facilities, housing; conflict in values and lifestyle between inmigrants and long-time residents; inmigrants represent 10% or more of baseline population; extended negotiations likely between developer and affected communities; affected communities will have great difficulty absorbing high social and economic costs of project without outside assistance	Potential delays due to community and local government resistance to facility; potential increased costs to local government; some community fears for changes in the quality of life accompanying influx of population; mitigation strategies available, but usually costly; moderate capacity of affected communities to absorb these impacts	Minor changes in local government's infrastructure Few inmigrants, or few cultural and and lifestyle clashes expected Mitigation costs easily absorbed by affected communities
Local economics	Implementation blocked due to unacceptable economic demands on local infrastructure	Potential delays due to lack of skilled personnel and financial impacts, but mitigation strategy possible	Infrastructure impacts minor Adaptability of community government high
Regional economics	Adverse capital or employment impacts on region Competitive position with other regions threatened	Potential employment, capital or competitive impacts, but mitigation strategy possible	No significant impacts
Institutional and legislative	Prohibition of implementation based on available strong legal constraints Anticipated legislative prohibition Absence of effective organizational responsibilities, statutes, etc.	Delay possible due to legal or political constraints Low to moderate public or private interest in enforcement	No significant opposition, legal constraints, or organizational problems

[a]Abbreviations: EPA, Environmental Protection Agency; NAAQS, National Ambient Air Quality Standards; NRC, Nuclear Regulatory Commission; OSHA, Occupational Safety and Health Act; PSD, Prevention of Significant Deterioration.

[b]These criteria were established by the Department of Energy, Division of Regional Assessments; variations from these definitions unique to this Federal Region are explained in the text.

Ecology/land use. For Region IV, ORNL chose to use the rating criteria specified in the first draft of the RIIA report. These ratings are:

- High — conflict with high value land use, such as loss of wetlands, cash crops, endangered species habitats, park land, waterfront, etc. Limited and costly mitigation options available.
- Medium — medium conflict with high value land use. Sites or mitigation measures readily available.
- Low — conflict with high value land use. Mitigation or alternative siting strategies costly but available.

Health/safety. ORNL has substituted for the criteria stated in Table 1.2 a method for ranking high, medium, and low health impacts that incorporates a risk philosophy developed by Starr.[1] The reference levels established range from the annual death risk due to natural events such as flood, lightning, snake bites, etc. (approximately 1 per 10^6 persons/year) to the normal U.S. disease death rate (approximately 1 per 10^2 persons/ year). Starr considers a risk high if it approaches that of disease death, moderate if the risk falls between 1 and 2 orders of magnitude below that of disease death, and low if it approaches the hazard level of natural events. For purposes of the present analysis, these designations have been given the numerical values of 5×10^{-3}/year, 1×10^{-4}/year, and 5×10^{-6}/year, respectively.[2] This procedure was used to develop a ranking of public health risk from exposure to fossil fuel combustion products in the region. It was assumed that combustion products originating from steam plants located within a state's boundaries were the source of $SO_4^=$ exposures for in-state residents only.

Visibility. Visibility impacts for the Southeast have been estimated by examining two criteria: projected changes in regional haze conditions and plume blight from specific power generating plants. Plume blight occurs when plumes from one or more power generating plants are visually identifiable with their sources. The regional haze conditions were estimated by calculating the total light extinction for Class I areas — as designated by the (EPA) — which is the sum of (1) light scattering due to gas molecules (Rayleigh scattering), (2) extinction due to the sources and light scattering aerosols accounted for in the interregional air quality analyses, and (3) the remaining light extinction due to the sources and light scattering aerosols not accounted for in the interregional air quality analyses. From these calculations, a total light extinction coefficient due to emissions from all sources and the calculated extinction coefficients for $SO_4^=$ and primary particulates due to utility and industrial emissions are calculated. The visual range in the Class I area is determined from this total light extinction coefficient. The percent change in this visual range for 1985 and 1990 from the calculated visual range for 1975 is compared. Class I areas that have significant impairment in visual air quality are identified.

The EPA has yet to determine standards for each Class I area. Consequently, ORNL has followed LASL's criteria for ranking the severity of impacts.

For regional haze, a low impact is less than a 10% decrease in the calculated visual range in a Class I area in the relevant time period; a moderate impact is a 10 to 20% decrease; and a high impact is a greater than 20% decrease.

For plume blight impact estimations, a low impact means that oil- or coal-fired power plants with less than 500 MWe capacity of gas-fired power plants of less than 1250 MWe capacity are sited in or adjacent to a county having a Class I area; a moderate impact means that oil- or coal-fired plants with 500 to 1000 MWe capacity or gas-fired plants with 1250 to 2500 MWe capacity are so sited; and a high impact means that oil- or coal-fired plants with more than 1000 MWe capacity or gas-fired plants with more than 2500 MWe capacity are so sited. (These criteria vary between fuel sources because emissions from gas-fired power plants are less conducive to visible haze formation.)

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2. C. Starr, R. Rudman, and P. Whipple, "Philosophical Basis for Risk Analysis," pp. 629-62 in *Annual Review of Energy*, vol. 1, ed. by J. M. Hollander and M. K. Simmons, Annual Reviews, Inc., Palo Alto, Calif., 1976.

2. REGIONAL OVERVIEW

The southeastern region is diverse in its energy needs and in its ability to meet these needs. This makes discussion of an energy problem or policy for the region as a whole difficult. For example, except for Hawaii, the state of Florida has the least heating degree days in the nation. Kentucky has seven times the number of heating degree days as Florida yet only 82% of the national average. The fossil energy resources of the region are concentrated in the coal fields of Kentucky, Tennessee, and Alabama. Except for modest amounts of oil and gas extraction in Mississippi and Florida, the rest of the region mines little fossil fuel. Paradoxically, the greatest growth in the region has been in Georgia, North Carolina, and Florida, which have few fossil energy resources of their own; Florida even imports some coal from overseas. The region has few large urban areas; of the 50 largest metropolitan areas in the U.S., only 7 are in the southeastern region, and 4 of these are in Florida.

Per capita personal income has historically been well below the national average. Mississippi, long one of the poorest states in the country, had a state per capita income of only 69% of the national average in 1975. Florida had the highest per capita income in the region, but it was still only 95% of that of the nation. Due in part to cost, the region's relatively mild climate, and cultural preferences, the region has a higher percentage of its housing stock in mobile and single-family homes than does the rest of the nation, and it relies more heavily on kerosene and liquified petroleum (LP) gas for heating. These and other characteristics set the region apart from the rest of the nation in its response to residential energy policy.

As a whole, the region has mixed views about environmental quality and economic growth. As a relatively poor section of the country, the region welcomes industrial and energy development, particularly in the poorer portions of the region. There is substantial reluctance to impose environmental or other regulations that might make the region less attractive as a place to do business. At the same time, Appalachia bears extensive strip mining scars, and rapid growth has strained the ability of Florida's land and water to support the state's current population. These problems could worsen, and there is support in the affected areas to act before they do. There is growing concern that the region avoid mistakes made in other parts of the nation, but this concern has had neither the publicity nor the success experienced elsewhere. Publicity over conflicts between energy and environment within the region has originated more from Federal decisions concerning the breeder reactor or the snail darter than from state or local action. Concerns over developing nuclear power plants, so great in other parts of the nation, are less apparent in the southeast Atlantic region than concerns over how environmental regulations will affect coal mining, coal exports to the rest of the country, and coal use within the region.

3. THE MID-RANGE PROJECTION SERIES C SCENARIO

3.1 National Scenario

The Series C Scenario represents a mid-term, i.e., 1985 to 1990, projection of energy development based on the assumption of medium supply, medium demand, and constant world oil prices. It projects the future on the basis of the continuation of policies prior to the implementation of the NEA. These are the assumptions for the scenario:

- slight increase of domestic oil production due to Alaskan oil field and outer continental shelf development;
- continued decline of natural gas production in lower 48 states;
- dramatic increase in coal production, particularly in the western states, due to an increasing demand coupled with rising domestic oil and gas prices;
- decrease in the growth rate of electricity sales from the historic 7% to 4.8% per year, representing saturation of air conditioning and major appliances that penetrated the market during the 1960's. The projected growth is consistent with 5% growth from 1970 to 1976 and 4.2% growth from 1976 to 1977;
- shift in the industrial sector from gas to oil, and to a lesser extent, to electricity, as indicated by fuel shares in the industrial sector.

Table 3.1 shows the overall scenario projections for energy supply and demand for 1985 and 1990. Figures 3.1, 3.2, and 3.3 show the average annual change in population, employment, and energy use, respectively, between 1975 and 1990 by U.S. Bureau of Economic Analysis (BEA) region. These growth rates were based upon the assumptions imbedded in the scenario and used ORNL's MULTIREGION and Regional Energy Balance System (REBS) models.[1,2] Total energy use is projected to increase from 72.6 quadrillion Btus (quads) in 1975 to 96 quads in 1985 and 110.9 quads in 1990. The total electricity distribution in 1975 was 2036 billion KWhr. The scenario projects it will reach 3045 billion KWhr in 1985 and 3692 billion KWhr in 1990. Electrical generation by Federal region is presented in Tables 3.2 and 3.3 for 1985 and 1990, respectively. These values are based on the scenario.

Table 3.1. National energy supply/demand balance for 1975, 1985, and 1990

(10^{15} Btu/year)

Projection series[a]	1975	1985	1990
Domestic production			
Crude oil	17.9	19.0	18.0
NGL and butane	2.6	2.0	1.8
Shale oil	0.0	0.1	0.3
Natural gas	19.0	17.2	16.7
Coal	14.6	23.1	27.5
Nuclear	1.8	6.2	10.3
Hydro and geothermal	3.2	4.2	5.0
Total	59.1	71.8	79.6
Imports			
Crude oil	8.7	16.5	20.9
Petroleum products	3.8	6.7	7.8
Natural gas	1.0	1.9	2.6
Total	13.5	25.1	31.3
Total, domestic production plus imports	72.6	96.9	110.0
Domestic consumption			
Oil	32.8	43.9	48.5
Natural gas	20.0	19.1	19.3
Coal	12.8	21.2	25.4
Nuclear	1.8	6.2	10.3
Hydro and geothermal	3.2	4.2	5.0
Total	70.6	94.6	108.5
Exports			
Coal	1.8	1.9	2.1
Refinery loss	0.2	0.4	0.3
Total	2.0	2.3	2.4
Total, domestic consumption plus exports	72.6	96.9	110.9
Domestic consumption by end-use sector[b]			
Residential	14.7	19.0	21.2
Commercial	11.3	13.5	15.0
Industrial	26.0	40.7	49.0
Transportation	18.6	21.4	23.3
Total	70.8	94.6	108.5

[a]Mid-Range Projection Series C.

[b]The difference between fuel consumption and end-use consumption is due mainly to conversion losses, particularly in the generation of electrical energy and in petroleum refining.

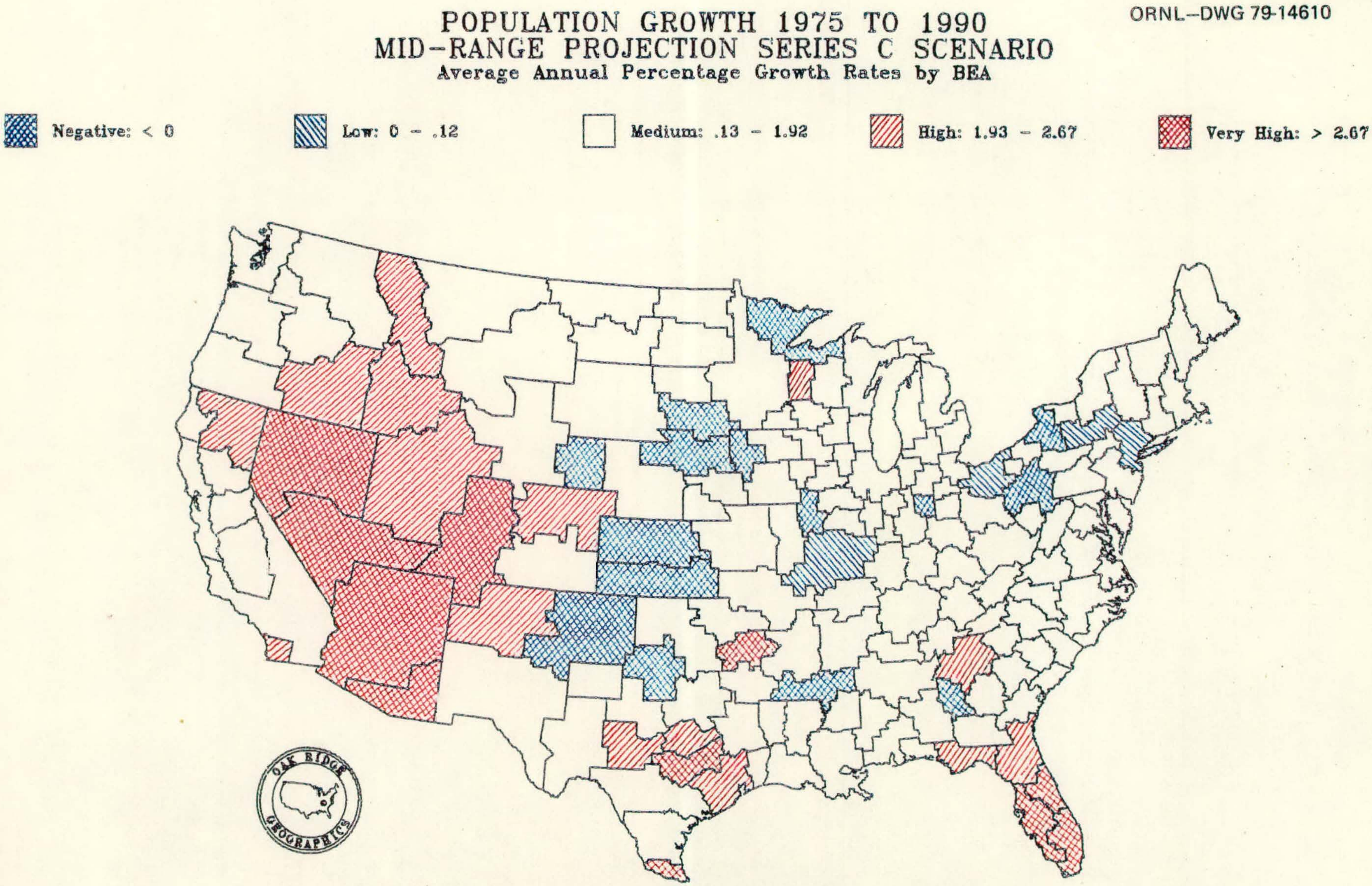

Fig. 3.1. Average annual growth in population between 1975 and 1990 by BEA region. These growth rates are based upon the Mid-Range Projection Series C Scenario, using ORNL's MULTIREGION model, a regional economic forecasting model.

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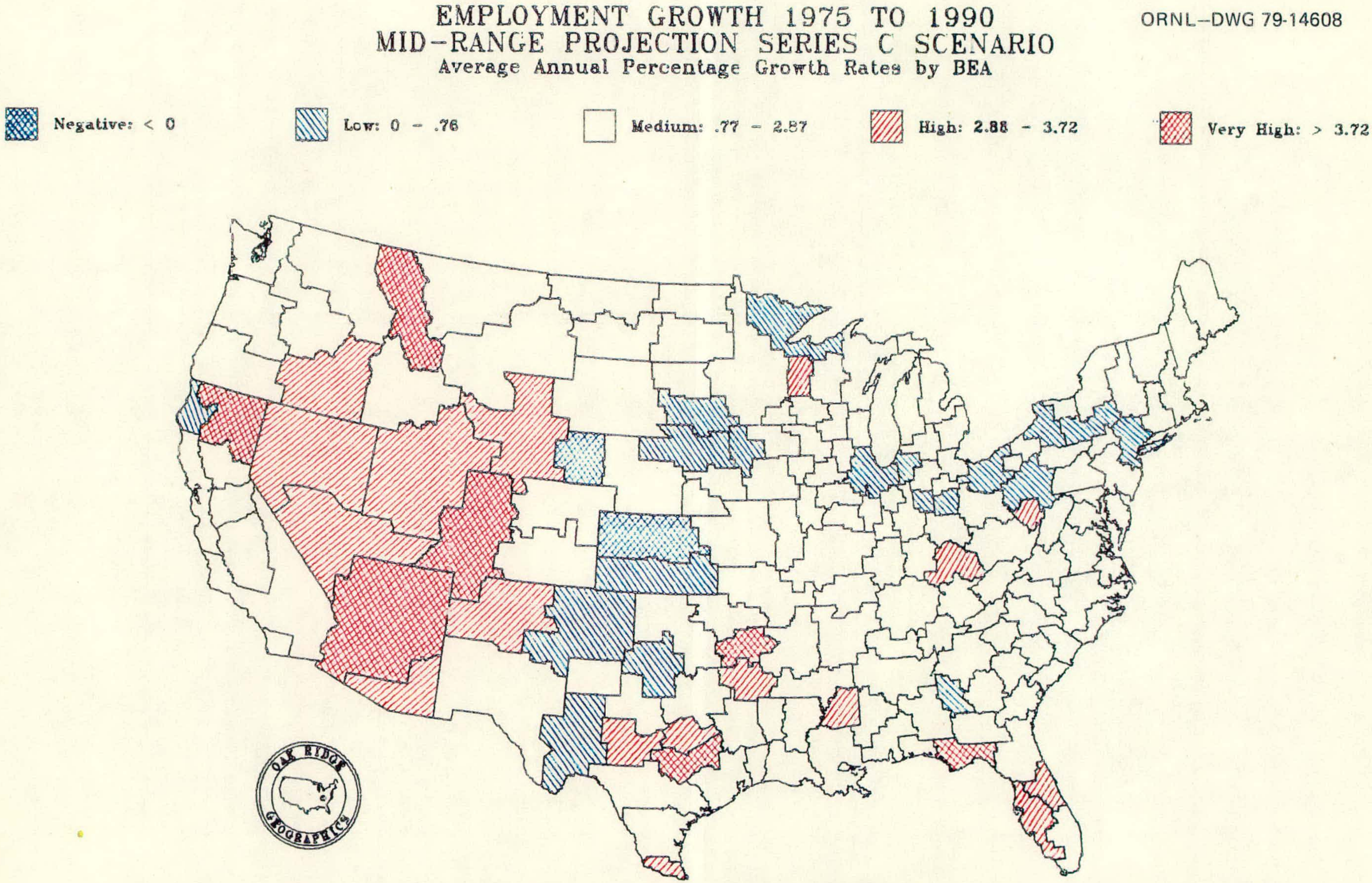

Fig. 3.2. Average annual growth in total employment between 1975 and 1990 by BEA region. These growth rates are based upon the Mid-Range Projection Series C Scenario, using ORNL's MULTIREGION model, a regional economic forecasting model.

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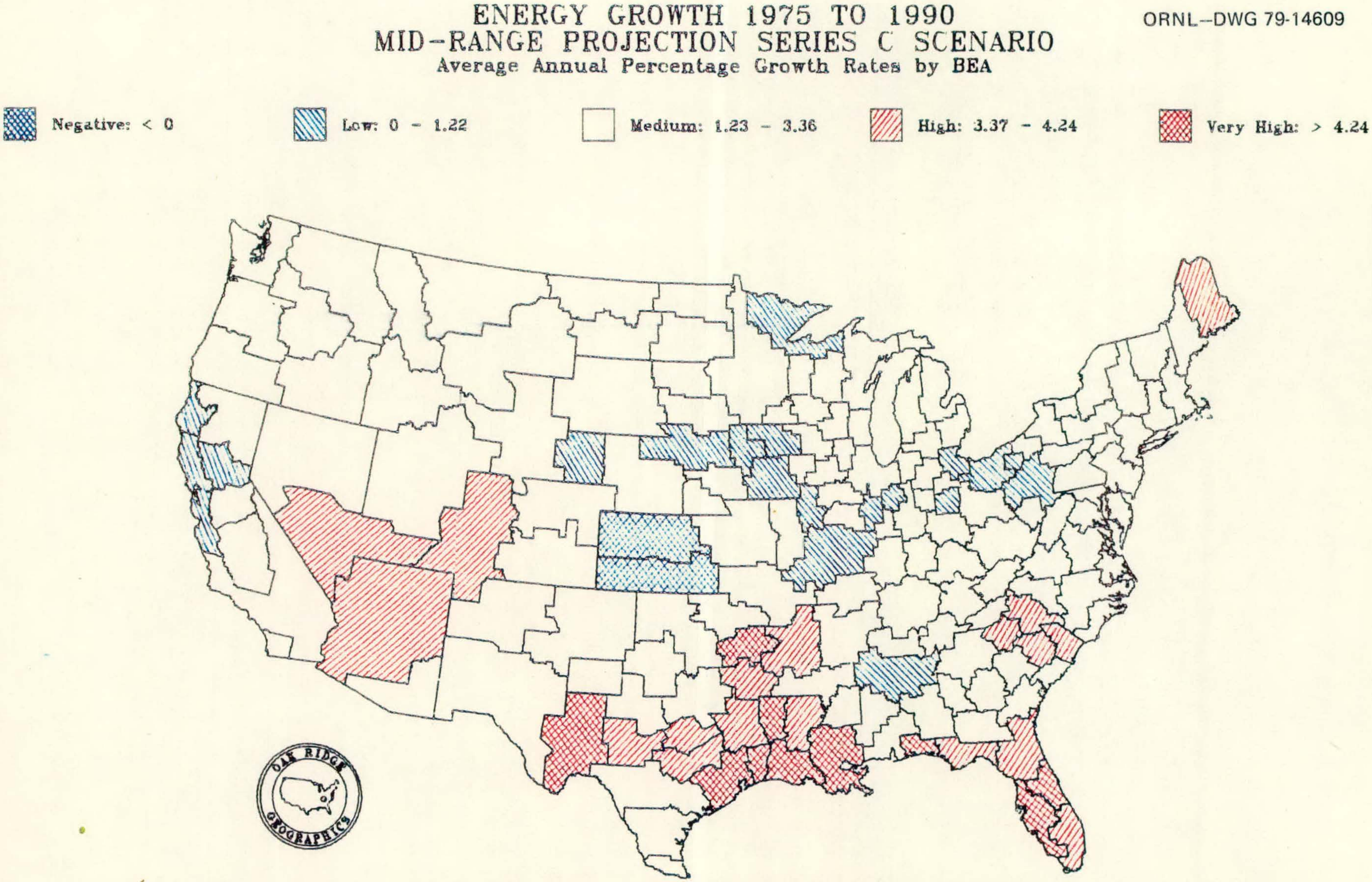

Fig. 3.3. Average annual growth in total energy use between 1975 and 1990 by BEA region. These growth rates are based upon the Mid-Range Projection Series C Scenario, using ORNL's Regional Energy Balance System [REBS], an energy use forecasting model.

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Table 3.2. National 1985 electric generation [GW(e)hr/year] for Mid-Range Projection Series C Scenario

Federal region	Gas peak	Oil peak	Nuclear	Combined cycle	Coal steam	Gas steam	Oil steam	Hydro	Solar	Geothermal	Pumped storage	Other
1		400	23,908	7,319	22,629		37,370	4,400	250		1,219	
2	70	3,104	52,377	8,871	77,779	0	47,076	36,342	250		1,999	
3	570	3,189	85,985	540	197,774	2,130	12,191	2,500			3,531	0
4	461	16,189	154,918	25,890	440,525	2,870	61,145	41,164			2,621	0
5	2,658	7,366	131,670	580	425,019	240	17,486	3,680	250		1,510	0
6	1,350	10,297	42,387	0	154,970	160,428	0	9,589	320		230	
7	0	3,620	17,990	190	117,979	4,800	0	2,740			1,220	
8	260	1,271	1,880		80,909		0	27,498	69		410	
9	1,759	140	35,417	8,881	28,358	25,918	51,350	57,986	70	16,120	3,090	
10	0	340	19,062	0	6,131	0	0	176,404			230	

Table 3.3. National 1990 electric generation [GW(e)hr/year] for Mid-Range Projection Series C Scenario

Federal region	Gas peak	Oil peak	Nuclear	Combined cycle	Coal steam	Gas steam	Oil steam	Hydro	Solar	Geothermal	Pumped storage	Other
1		430	57,324	5,940	21,361		18,482	4,869	2,000		1,249	
2	50	2,830	98,017	11,151	75,843		33,115	34,032	2,000		3,031	
3	570	2,628	93,457	540	245,110	3,630	12,937	2,850			5,710	0
4	0	21,110	267,930	25,639	587,581	0	35,268	40,506			4,070	0
5	1,841	10,565	200,952	15,151	461,016	0	6,907	4,110	2,000		1,511	0
6	1,340	12,082	77,587	0	214,506	123,952	0	9,161	3,070	7,010	570	
7	0	4,526	33,940	180	126,757	7,070	0	2,780			1,220	
8	260	1,461	1,380		91,865	0	0	28,900	1,070	6,310	410	
9	1,759	140	61,068	13,879	28,049	27,390	45,166	58,739	1,070	18,919	3,509	0
10		660	43,515	0	7,340	0	0	184,549		5,610	570	

3.2 Regional Scenario

3.2.1 Disaggregated scenario

The energy supply and demand scenario for Federal Region IV is summarized in Table 3.4. These projections were the basis for the county level utility, industrial, and mining siting patterns, developed by ORNL, BNL, and MITRE Corporation, which, in turn, provide the baseline for the impact statements. Whereas electrical generation accounts for over 75% of the industrial fuel use (thereby creating the larger proportion of environmental impacts), most of the analysis has focused on this sector. Figures 3.4 through 3.11 illustrate the regional distribution of electrical generation for coal, nuclear, oil, and gas between 1975 and 1990. Each graduated circle reflects the total electrical generation capacity for that county for the specified technology. All state projections are based upon the Mid-Range Projection Series C scenario and reflect the growth in electrical generation requirements to 1990.

3.2.2 Causal factors

There are many facets to the interaction of the Mid-Range Projection Series C Scenario with the characteristics of a region; these give rise to the impacts summarized in this document. The factors contributing to each impact are complex and variable, but they may be roughly grouped into the following categories.

- Ambient Environmental Quality — Existing conditions [e.g., nonattainment in Air Quality Control Regions (AQCRs)] will create conflicts with assumed energy utilization.

- Population/Economic Stress — General patterns of economic and population growth and, therefore, energy demand assumed by the projection have a more significant impact than the specific technology mix (for example, water availability patterns due to changing regional demographic and economic patterns). This implies some scenario-independent impact.

- Energy Scenario — Specific technology mixes, assumptions, and demand levels generate impacts such as (1) requiring the conversion of a large number of oil- and gas-fired boilers to burn coal or (2) the replacement of these boilers over time with new coal units.

REFERENCES FOR SECTION 3

1. R. J. Olson et al., *MULTIREGION: A Simulation Forecast Model for BEA Area Population and Employment*, ORNL/RUS-25 (1977).

2. D. P. Vogt et al., *REBS: A Methodology for Addressing the Regional Implications of National Energy Scenarios*, ORNL/TM report (to be published).

Table 3.4. Energy supply/demand balance for Region IV
(10^{15} Btu/year)

Projected series[a]	1975	1985	1990
Domestic production			
Crude oil	0.65	1.79	2.02
NGL and butane	0.09	0.19	0.20
Shale oil	0.00	0.00	0.03
Natural gas	0.21	0.36	0.38
Coal	4.06	4.96	5.38
Nuclear	0.37	1.58	2.93
Hydro and geothermal	0.44	0.45	0.50
Total	5.78	9.33	11.44
Imports			
Crude oil	0.35		
Petroleum products	2.87	3.80	3.90
Natural gas	1.67	1.30	1.16
Coal			1.41
Total	4.90	5.10	6.47
Total, domestic production plus imports	10.68	14.43	17.91
Domestic consumption			
Oil	5.03	6.49	7.09
Natural gas	1.79	1.66	1.54
Coal	3.27	4.92	6.79
Nuclear	0.37	1.58	2.93
Hydro and geothermal	0.44	0.45	0.50
Total	10.90	15.11	18.84
Exports			
Crude oil		0.579	0.658
Coal	0.61	0.026	
Refinery loss	0.01	0.02	0.01
Total[b]	0.62	0.61	0.67
Total, domestic consumption plus exports	12.07	15.75	19.51
Domestic consumption by end use sector[c]			
Residential	2.23	3.49	4.60
Commercial	1.49	2.07	2.44
Industrial	3.65	5.96	7.40
Transportation	3.20	3.92	4.44
Total	10.57	15.44	18.88

[a] Mid-Range Projection Series C

[b] Numbers do not add to totals because of rounding.

[c] The difference between fuel consumption and end-use consumption is due mainly to conversion losses, particularly in the generation of electrical energy and in petroleum refining.

ORNL DWG 79-14412

1975 COAL STEAM CAPACITY IN REGION IV

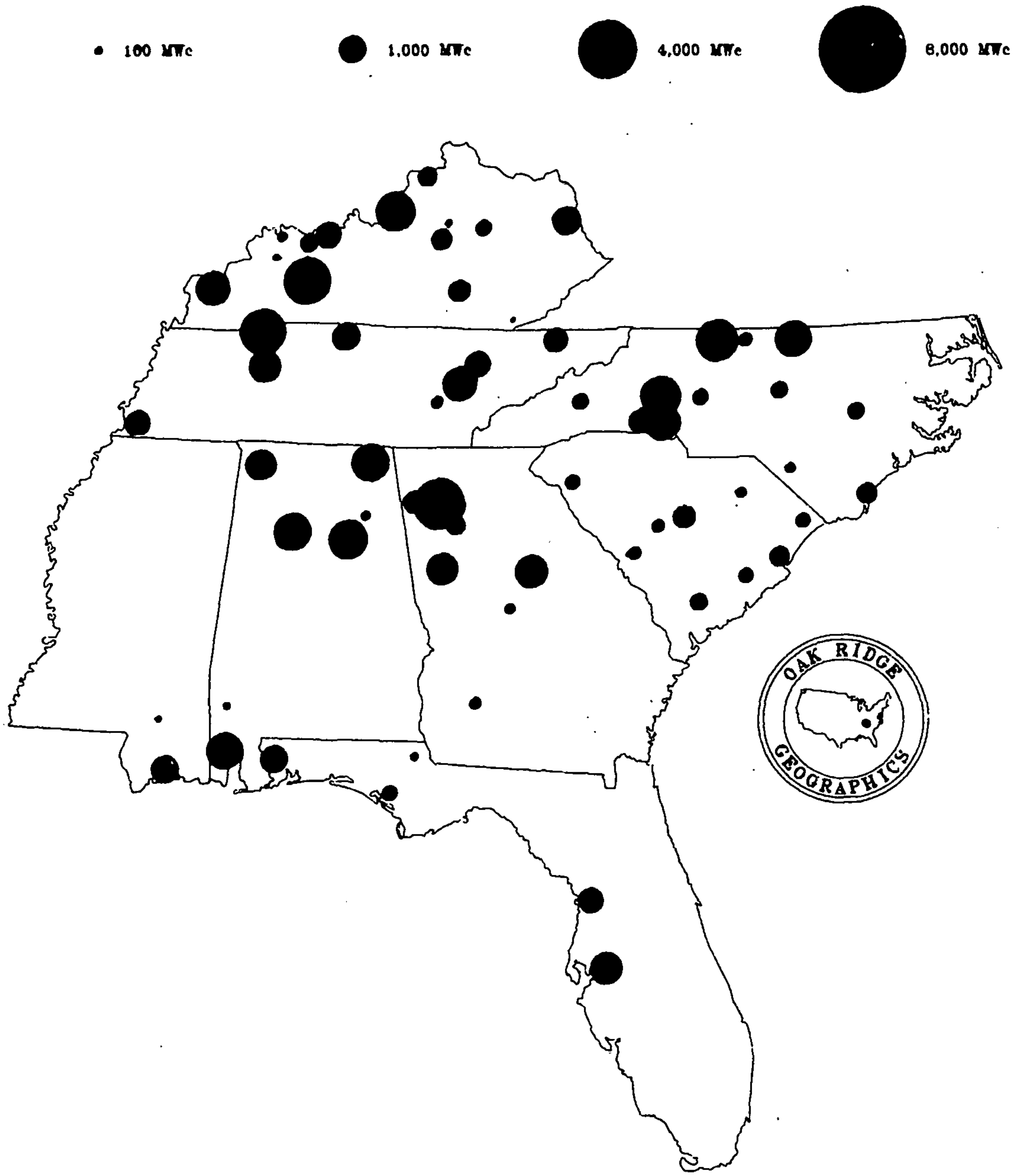


Fig. 3.4. Total coal steam-electric capacity by county for 1975.

ORNL DWG 79-14413

1990 COAL STEAM CAPACITY IN REGION IV

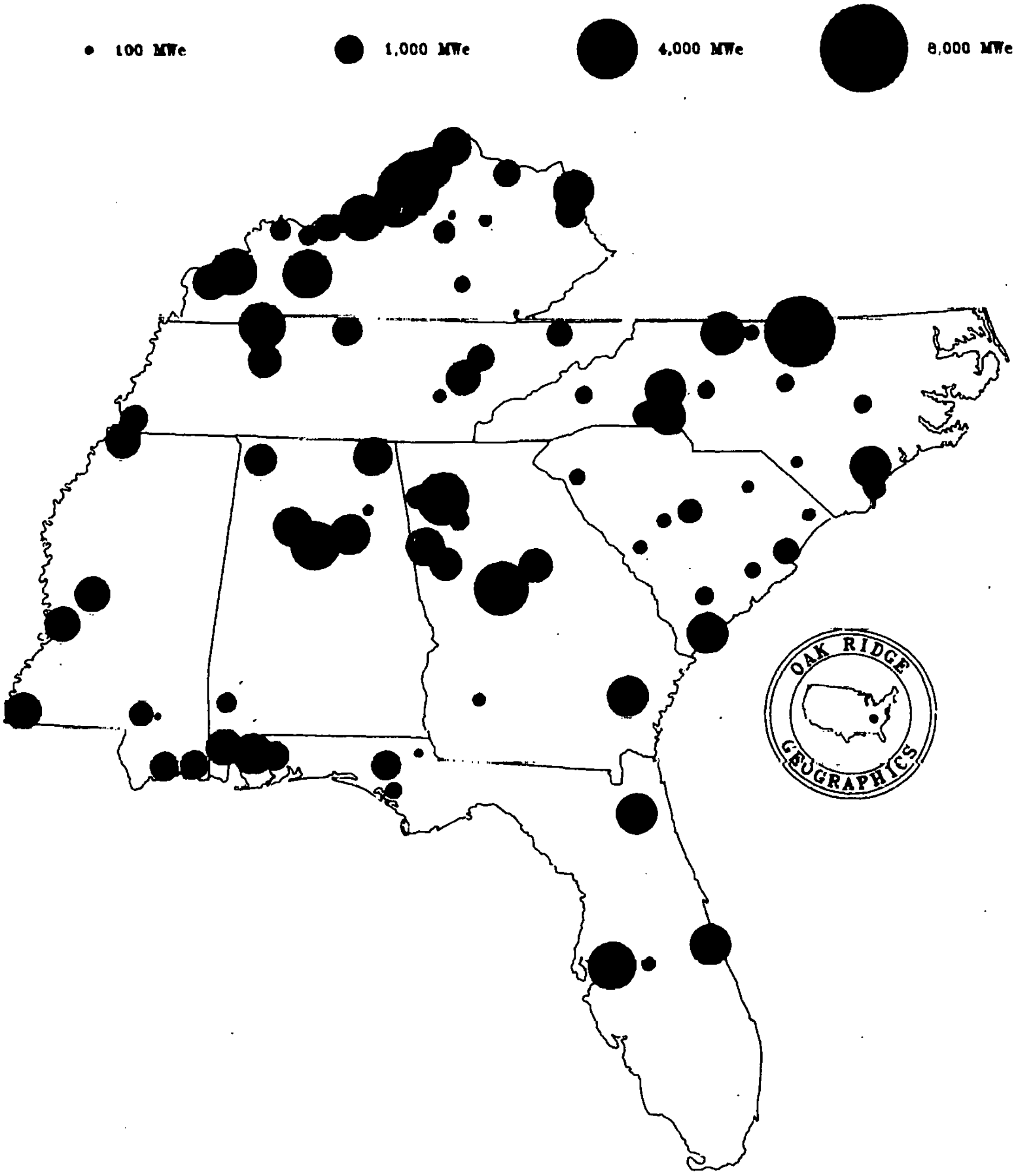


Fig. 3.5. Total coal steam-electric capacity by county for 1990.

ORNL DWG 79-14414

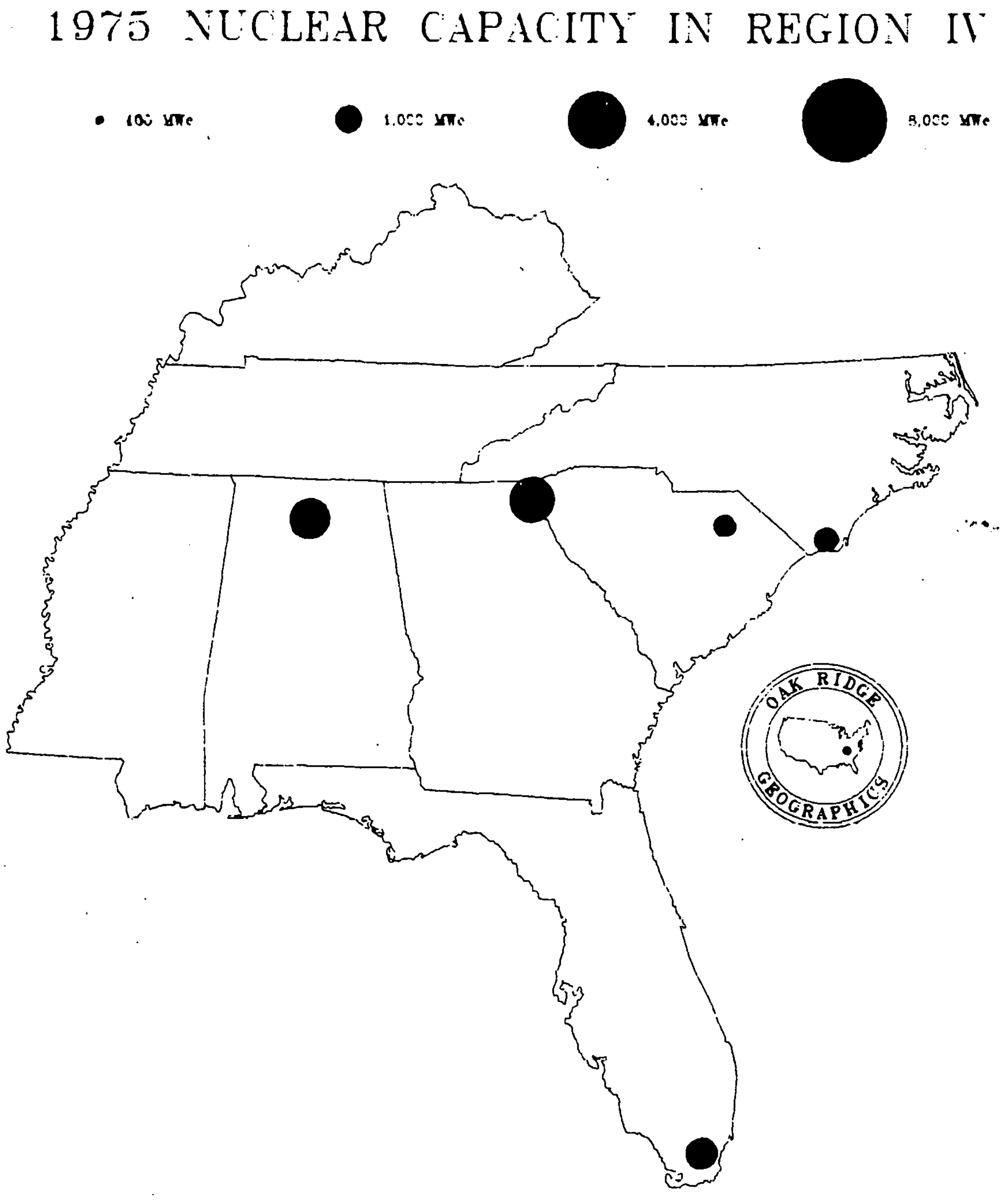


Fig. 3.6. Total nuclear steam-electric capacity by county for 1975.

ORNL DWG 79-14415

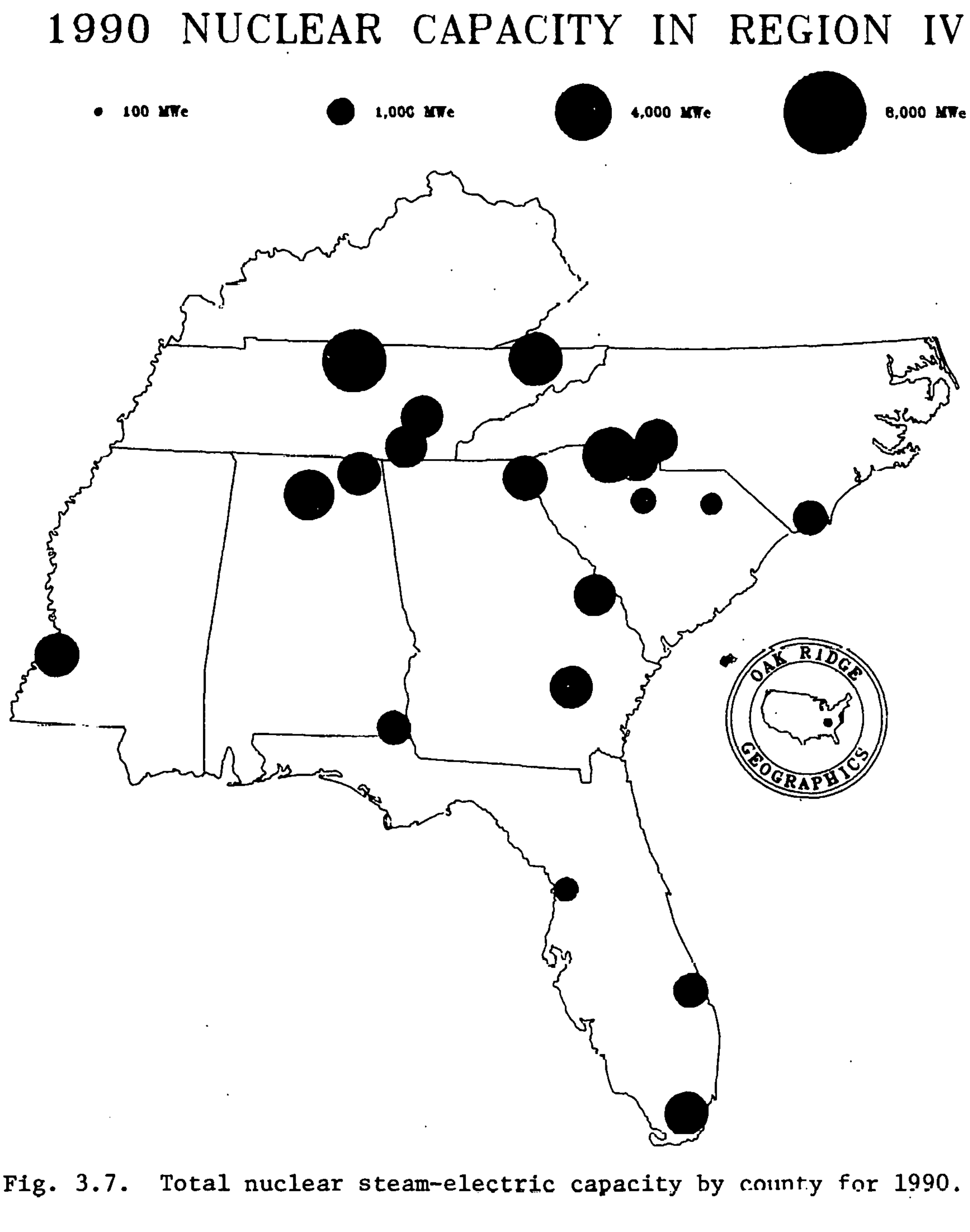


Fig. 3.7. Total nuclear steam-electric capacity by county for 1990.

ORNL DWG 79-14416

1990 OIL STEAM CAPACITY IN REGION IV

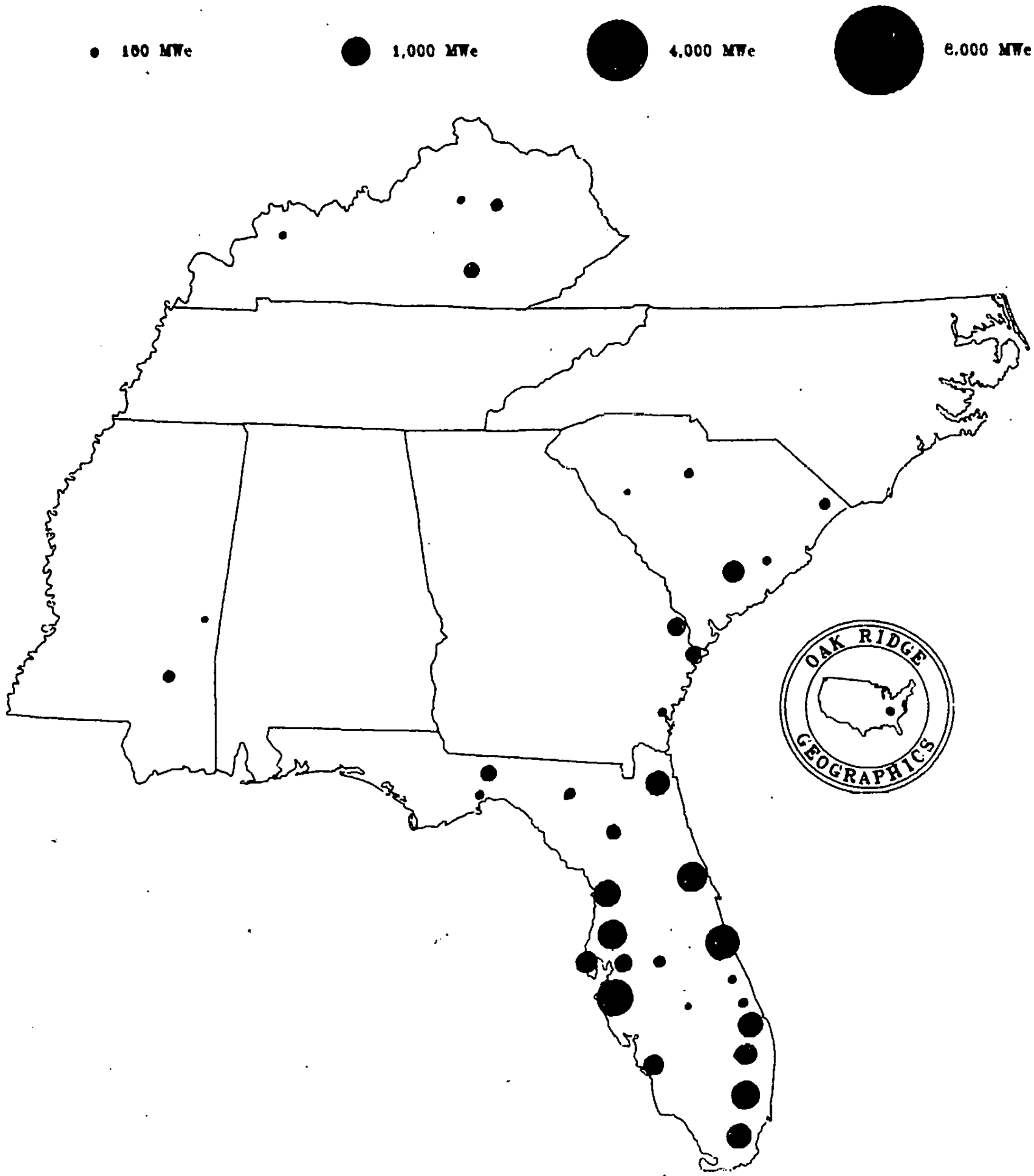


Fig. 3.8. Total oil steam-electric capacity by county for 1975.

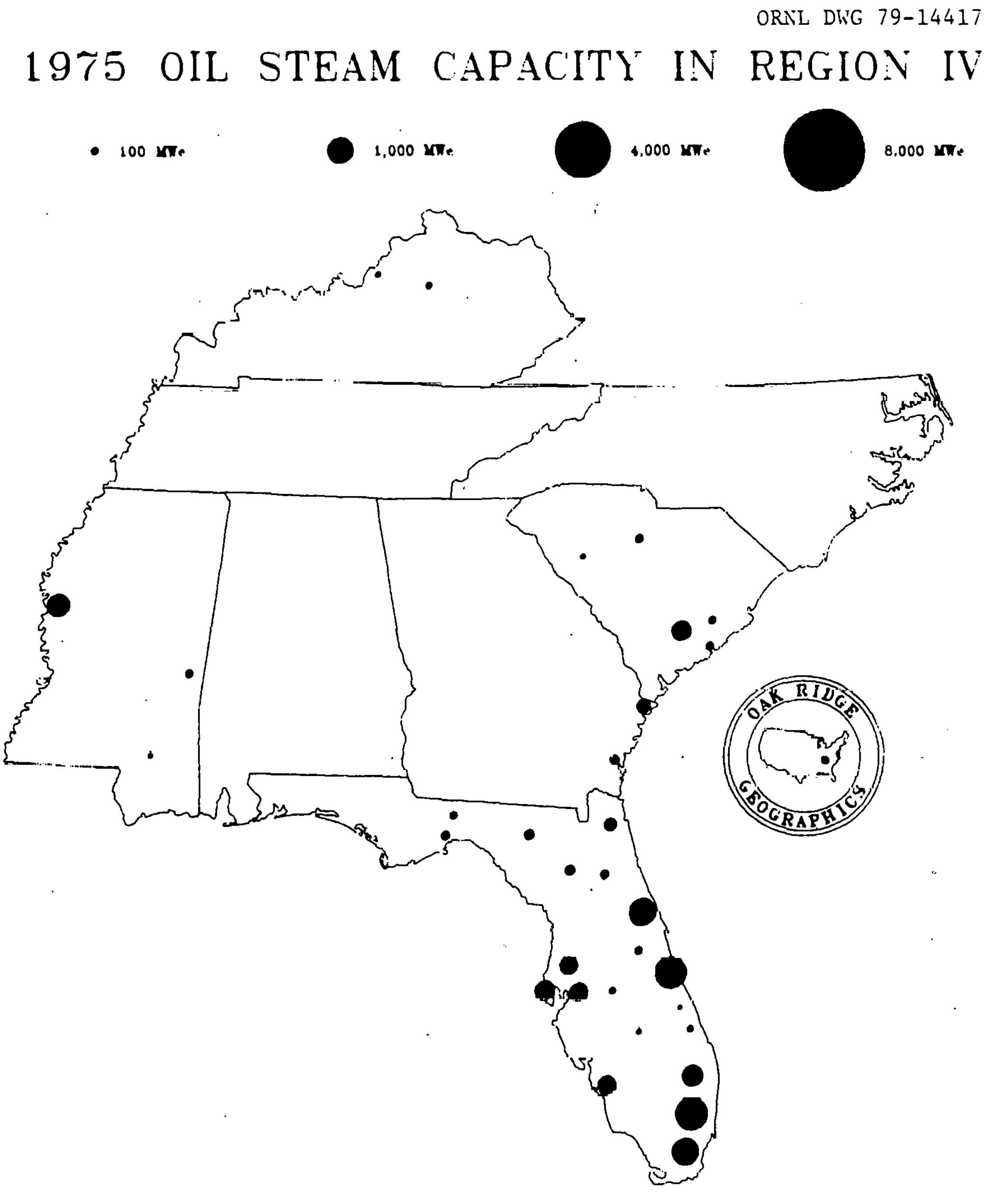


Fig. 3.9. Total oil cteam-electric capacity by county for 1990.

ORNL DWG 79-14418

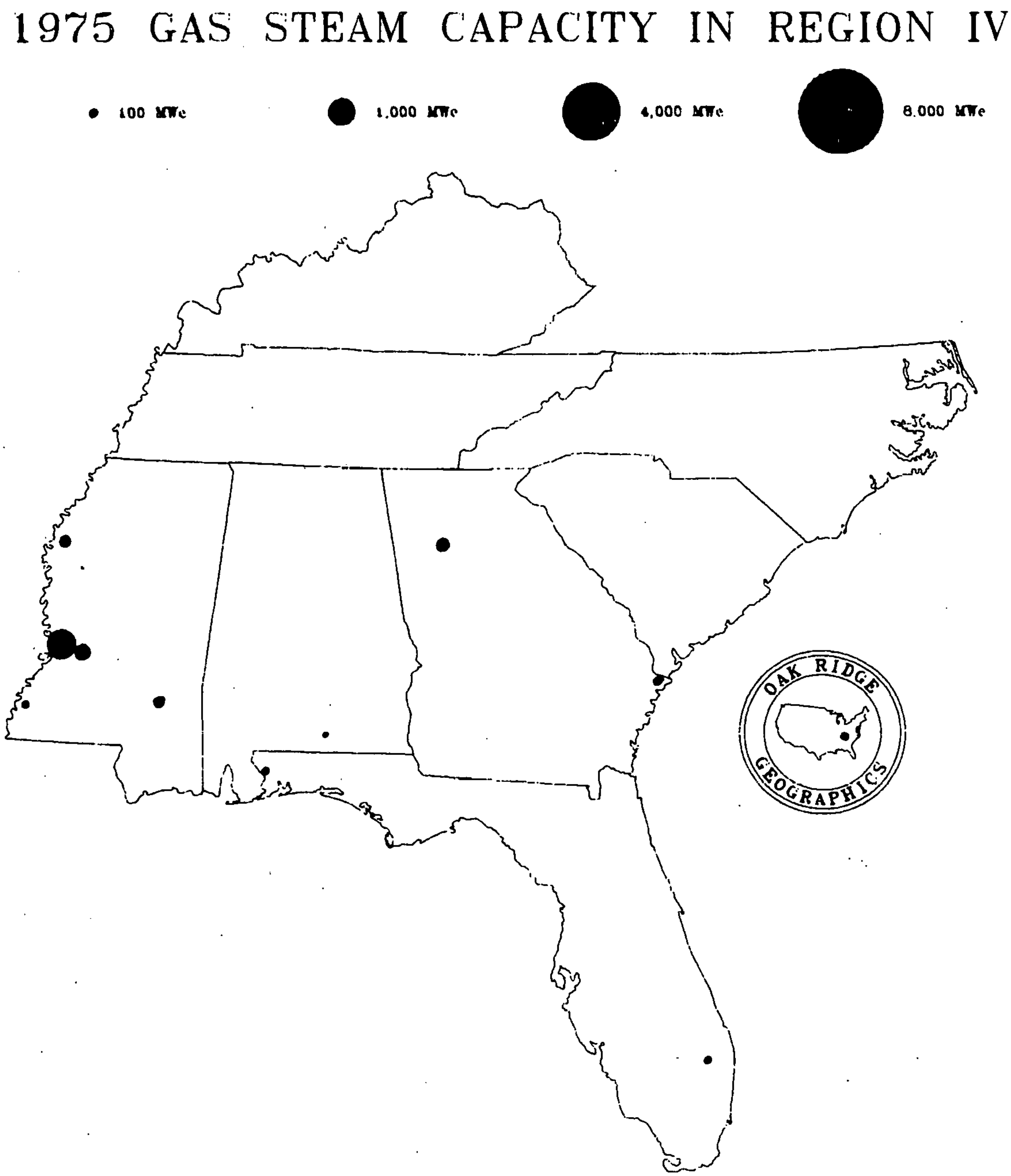


Fig. 3.10. Total gas steam-electric capacity by county for 1975.

ORNL DWG 79-14419

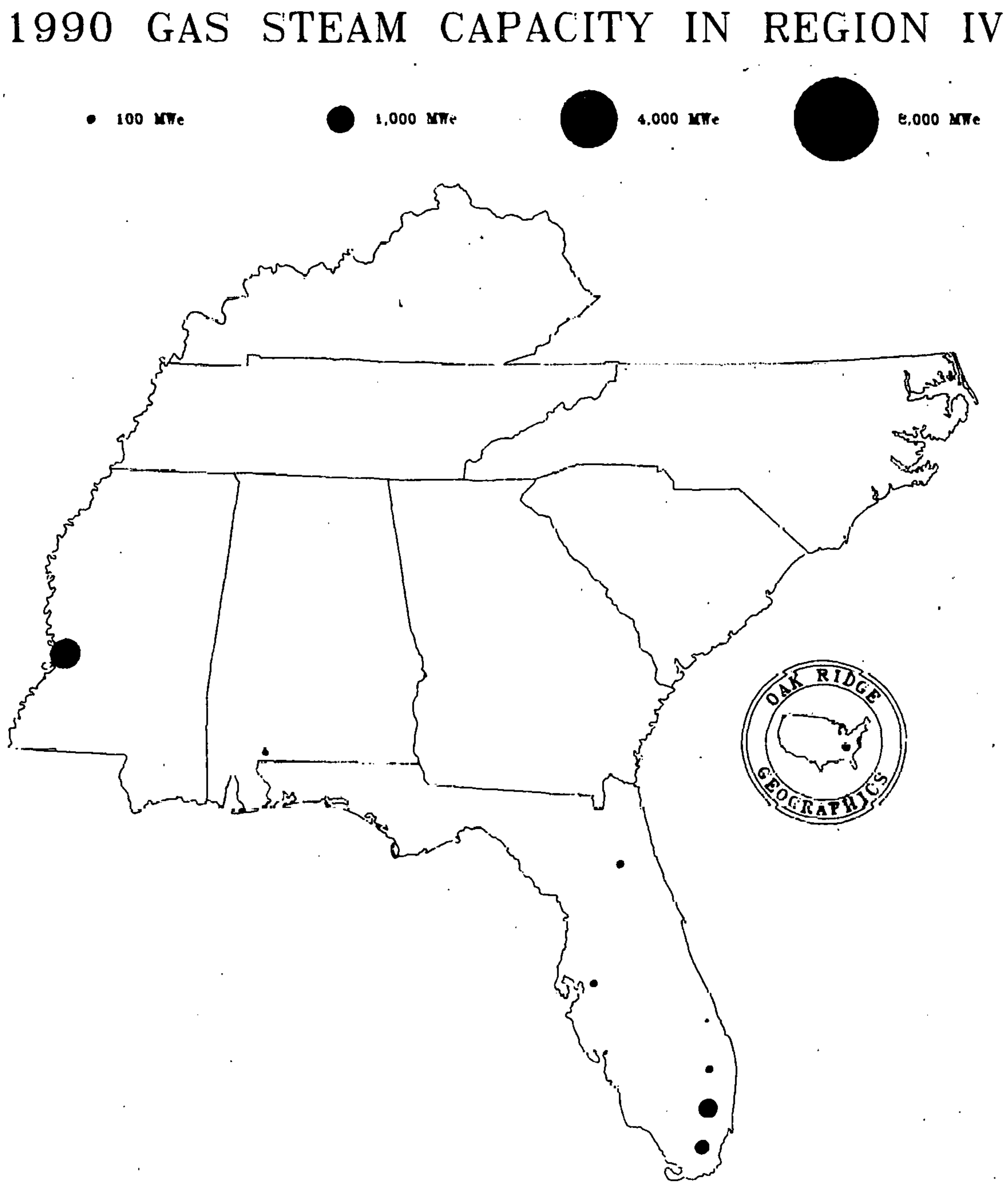


Fig. 3.11. Total gas steam-electric capacity by county for 1990.

4. REGIONAL ASSESSMENT

4.1 National Issues with Regional Impacts

A number of issues cannot be limited to state or even regional boundaries. They are the product of national or multiregional developments. Some issues under this analysis that fall naturally into this category are long-range transport of pollutants and national socioeconomic impacts. Additionally, impacts affecting major natural water systems may be a product of several of the regional entities assumed for this study. The issues, however, are of great importance because individual regions may bear disproportionately both the impacts and the cost of proposed remedies.

4.1.1 Long-range transport/visibility

Because of the high probability that coal burning will increase in Texas, Louisiana, Arkansas, and Oklahoma, those states in Region IV within the normal air flow path of the Southwest (particularly Kentucky and Tennessee) will be exposed to increasing concentrations of SO_2 and sulfates, even with National Ambient Air Quality Standards (NAAQS).

4.1.2 National socioeconomic issues

Because of national demand for skilled construction and operation manpower, not only in energy but also in other industries, the Southeast could experience possible shortages if the Series C Scenario is realistic. Energy development in Region IV could be constrained in acquiring construction capital because of competing national demands. In addition, nuclear development will be affected by whether the nation resolves current reactor safety and waste disposal issues. These issues are closely tied to how the nation decides to handle licensing procedures.

In recent years it has become evident that considerable conflict exists in the federal-state-local infrastructure of authority. Disagreement among federal, state, and local agencies with regard to control of energy resources and who will use them has become a major national issue. A conflict also exists between national commitments for energy development and the desire to preserve the environment. This is exemplified by the conflicting goals of the coal conversion section of the NEA and the Clean Air Act Amendments of 1977.

In terms of health and safety, several federal acts and compliance issues will affect the well-being of residents in the Southeast. Enforcement of surface mining legislation will improve the water quality and diminish the possibility of health impacts in the region. Also, compliance with the clean air standards adopted by EPA will significantly reduce the exposure levels of SO_2 and sulfates currently experienced by residents in the Southeast, particularly in Kentucky and Tennessee. Finally, enforcement of safe underground mining practices will reduce the additional mine deaths that could result from the Scenario's coal production levels.

4.1.3 Inland and coastal water resources

Current EPA regulations regarding thermal discharge from power plants should be reexamined in view of the possible water shortage problems identified in the Series C Scenario. The current emphasis on closed cycle cooling (e.g., wet cooling towers), in effect, may be trading the thermal problems of once-through cooling systems for a plethora of problems and conflicts associated with increased water consumption. Research and development of cooling options that require less water, including evaluation of state and federal regulations that inhibit full utilization of residual heat, also should be examined. Analysis of alternative sources of cooling water, including groundwater, consideration of alternate use of new and existing reservoir storage capacity, and use of saline water, are especially needed to identify viable mitigation strategies.

An appraisal of how state legislatures can best deal with water shortages is needed by the states, particularly those states following the riparian doctrine and containing problem basins defined in this analysis. Finally, data and projections of water use by competing (nonenergy) sectors is greatly needed to assess water availability conflicts.

4.2 Regional Issues

The following is a summary of the environmental, social, and economic impacts of the scenario on the southeastern region. Issues identified are those impacting more than one state in the region.

4.2.1 Local air quality/visibility

Violations of NAAQS for total suspended particulates (TSP), carbon monoxide (CO), and photochemical concentrations are currently occurring in several metropolitan areas in Region IV, most notably Atlanta, Memphis, Birmingham, and Mobile. Violations for SO_2 are occurring around several Tennessee Valley Authority (TVA) coal-fired electric plants located near Paducah, Kentucky; Waverly, Tennessee (Johnsonville steam plant); and in northeastern Alabama (Widows Creek). Recent agreements between TVA and EPA will ease many of these problems. The region's air quality is only moderately impacted at present, but problems with air quality could worsen if the conversion of oil and gas boilers to burn coal occurs.

Overall, air quality in Region IV is not expected to improve appreciably during the period from 1975 to 1990 because emissions of noxious gases and particulates to the atmosphere are likely to increase due to more burning of coal. Table 4.1 provides a summary of SO_2 and TSP emissions by states for 1975 and those predicted for 1990. Table 4.2 displays data on SO_2 and nitrogen oxide (NO_x) emissions for 1975, 1985, and 1990 for each of the Air Quality Control Regions (AQCRs) in Region IV. (See Fig. 4.1 for distribution of AQCRs.) Although SO_2 may not be a severe problem, except in localized situations, it is readily converted in the atmosphere to sulfates which are thought to have significant health effects. Sulfur dioxide, sulfates, and NO_x all contribute to increasing acid rain. The pH of many lakes, particularly in the Northeast, is now so low that fish populations are greatly reduced.[1] NO_x is also a factor in increased ozone levels found in selected areas of the Southeast.

Particulate emissions can cause problems due to the presence of undesirable trace elements, such as arsenic, cadmium, fluorine, and selenium, and trace organics such as benzpyrene.[2] Emissions of selenium are expected to increase with additional coal combustion because it is volatile and cannot be easily controlled. Also, because coal contains trace amounts of uranium, thorium, and their decay products, increased levels of radioactivity in the atmosphere may result from burning more coal.

Local air quality assessment. Where available, the following data were provided by ANL on a county-by-county basis: utility and industrial SO_2 and TSP emissions for 1975, 1985, and 1990; 1975 ambient air quality for SO_2 and TSP and projections for 1985 and 1990; and an air quality impact assessment. The BNL long-range transport data were used for the 1985 and 1990 projections. The emissions assumptions were: State Implementation Plan (SIP) compliance by 1983 for existing sources, ESECA conversions included; 90% SO_2 control for new utility sources; existing New Source Performance Standards (NSPS) controls for new industry sources; and 99% TSP control for new sources. PSD Class I areas are shown in Fig. 4.2. The air quality (AQ) impact assessments are based on the following criteria: incremental AQ changes are compared with allowable PSD increments for Class I or Class II areas, as appropriate; ambient AQ levels for 1985 and 1990 are compared with appropriate NAAQS; and percentage increase in emissions is calculated if no ambient data are available, and counties are noted if the increase is greater than 25%.

Factors not included in the analysis are: contributions from long-range transport, subcounty siting factors in large counties, changes in emissions from sectors other than utility and industrial fuel combustion, real distribution of metallurgical coal, local air quality regulations, contributions from rural fugitive dust, and cross-county impacts.

Table 4.3 summarizes the ambient air quality (AAQ) and incremental air quality (IAQ) results by listing the number of counties in each state for which nonattainment occurs or where there are PSD incremental violations.

Table 4.1. Summary of SO_2 and TSP emissions for Region IV (10^3 tons per year)[a]

	SO_2			TSP		
	1975	1990	Percent change from 1975	1975	1990	Percent change from 1975
Alabama	977	912	− 7	737	276	−63
Florida	834	1379	+65	380	417	+10
Georgia	620	999	+61	287	281	− 2
Kentucky	1489	1944	+31	411	349	−15
Mississippi	145	271	+87	51	65	+27
North Carolina	472	873	+85	342	246	−28
South Carolina	203	293	+44	155	128	−17
Tennessee	1205	960	−20	608	225	−63
Totals	5945	7631	+28	2971	1987	−33

[a]Data taken from the Strategic Environmental Assessment System (SEAS), Mid-Range Projection Series C. TSP = total suspended particulate.

Table 4.2. Annual SO_2 and NO_x emissions by air quality control regions[a] (kilotons per year)

Air quality control region		SO_2			NO_x		
		1975	1985	1990	1975	1985	1990
1	Alabama and Tombigbee Rivers	14	42	50	16	31	34
2	Columbus-Phoenix City	11	17	20	37	32	30
3	East Alabama	17	23	25	25	24	24
4	Metropolitan Birmingham	275	280	333	177	220	249
5	Mobile-Pensacola-Panama City-Southern Mississippi	504	617	689	246	347	378
6	Southeastern Alabama	1	134	172	11	44	53
7	Tennessee River Valley-Cumberland Mountains	573	245	241	139	136	132
13[b]	Metropolitan Memphis	114	100	93	65	67	57
48	Central Florida	51	11	16	80	50	41
49	Jacksonville-Brunswick	128	75	82	104	76	73
50	Southeastern Florida	95	34	45	224	143	118
51	Southwestern Florida	20	4	4	30	16	14
52	West-central Florida	497	601	609	158	187	201
53	Augusta-Aiken	36	42	45	42	42	42
54	Central Georgia	75	197	260	69	133	169
55	Chattanooga	323	293	281	107	104	107
56	Metropolitan Atlanta	105	180	217	137	161	174
57	Northeastern Georgia	3	5	7	24	19	18
58	Savannah-Cairo	54	56	63	42	44	44
59	Southwestern Georgia	26	31	32	33	29	28
72[b]	Paducah-Cairo	1237	1358	1243	235	299	274
77	Evansville-Owensboro-Henderson	631	537	600	115	209	257
78[b]	Louisville	367	316	321	106	126	130
79[b]	Metropolitan Cincinnati	433	268	303	145	179	200
101	Appalachian	8	8	8	24	20	18
102	Bluegrass	74	82	84	44	42	45
103[b]	Huntington-Ashland-Portsmouth-Ironton	699	1023	916	217	315	307

Table 4.2. (continued)

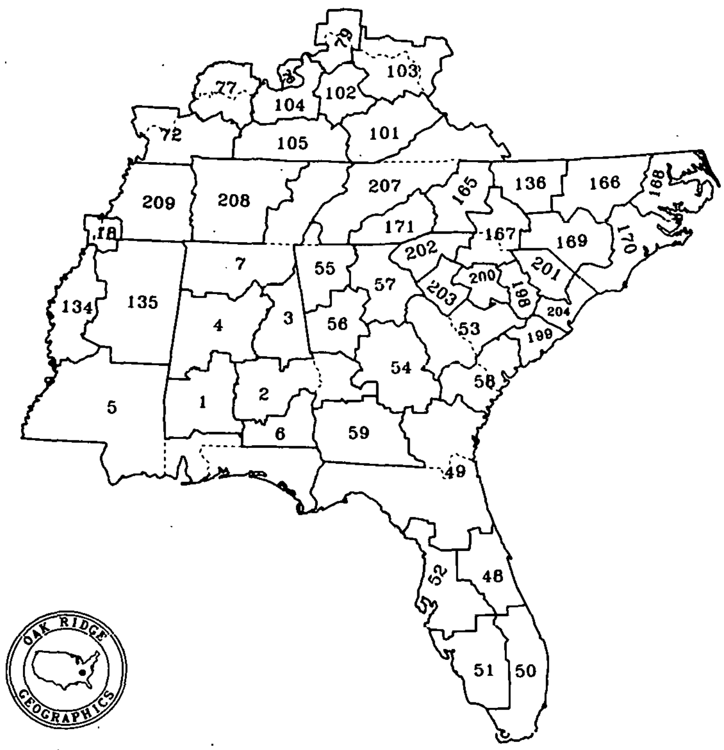
Air quality control region	SO_2			NO_x		
	1975	1985	1990	1975	1985	1990
104 North-central Kentucky	3	28	37	12	23	27
105 South-central Kentucky	42	47	46	26	24	23
134 Mississippi Delta	6	4	4	18	15	12
135 Northeastern Mississippi	6	9	12	32	27	26
136 Northern Piedmont	30	34	39	56	50	52
165 Eastern Mountain	168	229	256	121	154	172
166 Eastern Piedmont	119	144	155	94	103	109
167 Metropolitan Charlotte	116	155	166	121	138	140
168 Northern Piedmont	28	47	60	14	12	12
169 Sandhills	12	13	15	28	24	23
170 Southern Coastal Plain	79	80	80	57	56	54
171 Western Mountain	45	42	38	35	29	27
198 Camden-Sumter	5	11	9	9	13	10
199 Charleston	47	27	28	44	30	29
200 Columbia	58	150	202	43	91	124
201 Florence	10	12	14	19	17	15
202 Greenville-Spartanburg	29	33	39	46	39	40
203 Greenwood	2	3	3	8	6	6
204 Georgetown	16	27	34	14	19	23
207[b] Eastern Tennessee-Southwestern Virginia	611	791	749	253	326	296
208 Middle Tennessee	777	440	419	171	171	166
209 Western Tennessee	4	9	13	25	22	22
Total	3584	8914	9177	3898	4484	4627

[a]Data taken from Strategic Environmental Assessment System (SEAS), Mid-Range Projection Series C. See Fig. 4.1 for Air Quality Control Region boundaries.

[b]Includes a portion outside Region IV.

ORNL-DWG 79-11242

AIR QUALITY CONTROL REGIONS IN REGION IV



AQCR	AQCR NAME
1	ALABAMA AND TOMBIGBEE RIVERS
2	COLUMBUS - PHENIX CITY
3	EAST ALABAMA
4	MET. BIRMINGHAM
5	MOBILE - PENSACOLA - PANAMA CITY - SOUTHERN MISS.
6	SE ALABAMA
7	TENNESSEE RIVER VALLEY - CUMBERLAND MTS.
18	MET. MEMPHIS
48	CENTRAL FLORIDA
49	JACKSONVILLE - BRUNSWICK
50	SE FLORIDA
51	SW FLORIDA
52	WEST CENTRAL FLORIDA
53	AUGUSTA - AIKEN
54	CENTRAL GEORGIA
55	CHATTANOOGA
56	MET. ATLANTA
57	NE GEORGIA
58	SAVANNAH - BEAUFORT
59	SW GEORGIA
72	PADUCAH - CAIRO
77	EVANSVILLE - OWENSBORO - HENDERSON
78	LOUISVILLE
79	MET. CINCINNATI
101	APPALACHIAN
102	BLUEGRASS
103	HUNTINGTON - ASHLAND - PORTSMOUTH - IRONTON
104	NORTH CENTRAL KENTUCKY
105	SOUTH CENTRAL KENTUCKY
134	MISSISSIPPI DELTA
135	NE MISSISSIPPI
136	NORTHERN PIEDMONT
165	EASTERN MOUNTAIN
166	EASTERN PIEDMONT
167	MET. CHARLOTTE
168	NORTHERN COASTAL PLAIN
169	SANDHILLS
170	SOUTHERN COASTAL PLAIN
171	WESTERN MOUNTAIN
198	CAMDEN - SUMTER
199	CHARLESTON
200	COLUMBIA
201	FLORENCE
202	GREENVILLE - SPARTANBURG
203	GREENWOOD
204	GEORGETOWN
207	EASTERN TENNESSEE - SW VIRGINIA
208	MIDDLE TENNESSEE
209	WESTERN TENNESSEE

Fig. 4.1. Air quality control regions in Region IV.

ORNL-DWG 79-12604

CLASS I AREAS – REGION IV

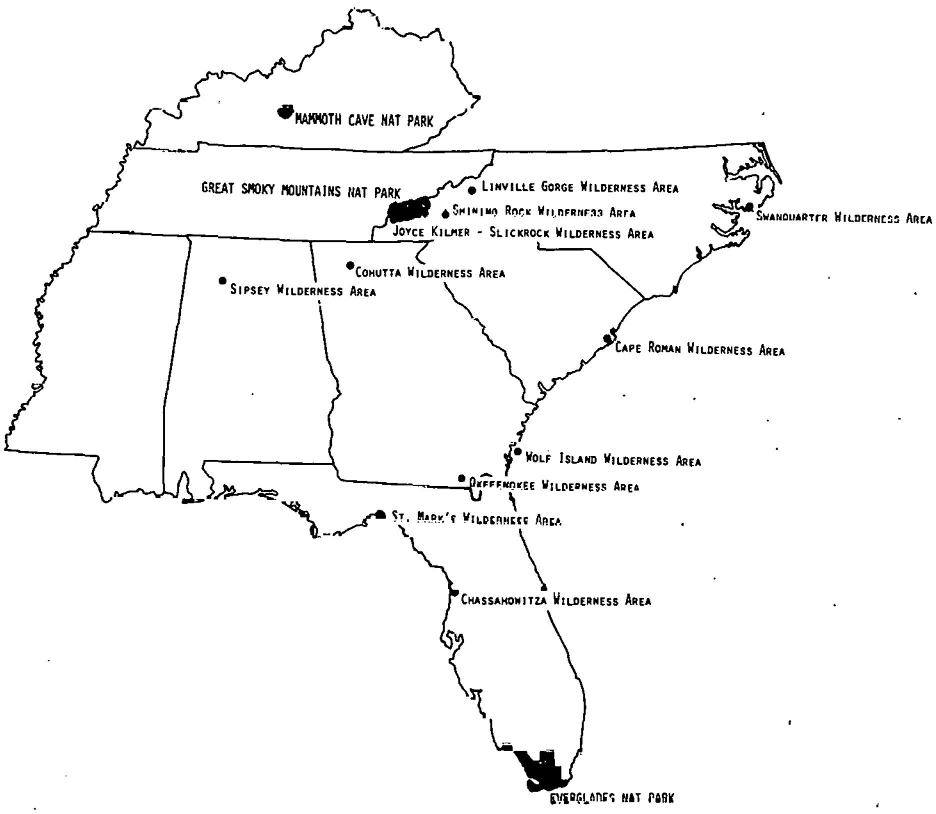


Fig. 4.2. Class I areas in Region IV.

Table 4.3. Number of counties in each state with violations in ambient and incremental air quality, 1975-1990[a]

	Number of counties			Number of counties with violations of air quality standards									
				Ambient air quality[b]						Incremental air quality			
	Total	With data[c]	Number of PSD Class I counties[d]	1975		1985		1990		1985		1990	
				SO_2	TSP	SO_2	TSP	SO_2	TSP	SO_2	TSP	SO_2	TSP
Alabama	67	24		1	4			1		1			
Florida	67	39	5		1	1	1[e]	1	1				
Georgia	159	29		1	1	1		1			3		1
Kentucky	120	30		4	6		6		5		1		
Mississippi	82	17			1							1	
North Carolina	100	40	3		4		4[e]		3[e]	1	1	2	1
South Carolina	46	27	1		2	1	2	1	1	1		2	
Tennessee	95	23	1	1	6		5		3		1		1
Total	736	229	10	7	25	3	18	4	13	3	6	5	3

[a]County data provided by Argonne National Laboratory.

[b]Several counties lack historical data for predicting changes in air quality. This number reflects the total number of counties with existing air quality data to determine ambient conditions.

[c]PSD = prevention of significant deterioration.

[d]TSP = total suspended particulates.

[e]Includes one county in a PSD Class I area.

For Region IV, only 229 of the 736 counties, including 10 nonattainment counties in Class I areas, are able to be studied as air quality in the remaining counties has not been studied by EPA. In 1975, 7 counties were in nonattainment for SO_2 and 24 counties for TSP. The corresponding numbers are 3 and 19 in 1985, and 4 and 13 in 1990. In 1985, there will be three counties with PSD increment violation for SO_2 and six counties for TSP. In 1990, the corresponding numbers are five and three. Because our present laws state that there will be no nonattainment areas in 1990, the counties listed represent potential trouble spots which will have to be corrected by that date. Only two of the Class I counties are in the nonattainment category (both for TSP) in 1985 or 1990. Figures 4.3 to 4.5 indicate the corresponding AQCRs involved. Figures 4.6 to 4.8 show the sulfur oxide (SO_x) emissions in the AQCRs of Region IV for the three years.

Table 4.4 summarizes the air quality impact assessment for 1985 and 1990. In addition to noting counties for nonattainment or increment violations, any county that will experience a greater than 25% increase in emission but has no 1975 AAQ data is noted for further investigation. The numbers for nonattainment are similar to those in Table 4.3. Also included are counties where NAAQS or the PSD Class II increment is exceeded.

Long-range transport assessment. Data on the long-range transport of SO_2 were obtained from BNL. Table 4.5 lists total fuel consumption, electrical generation, and SO_2 emissions for Region IV for each of the scenarios. Coal is the predominant fuel for utility use during the entire period. The following data for both SO_2 and sulfate ($SO_4^=$) were provided for each state: area; population; concentration of pollutant (maximum, minimum, average, and population-weighted average); and exposure (product of population and population-weighted average concentration). This information forms the basic input to the health impact assessment.

4.2.2 Water quality/availability

Water for energy will be a major concern for energy development throughout Region IV. However, widespread water shortages are generally not apparent at the aggregated subarea (ASA) level. Figure 4.9 illustrates the ASAs used in the analysis of Region IV. Figure 4.10 highlights the primary areas of concern for water availability in Region IV. Although the region's total runoff is the greatest in all the eastern United States, most of the load centers (including Birmingham, Alabama; Atlanta, Georgia; and Charlotte, Greenville, and Winston-Salem, North Carolina) are situated in inland headwater areas where low-flow problems result from periodic droughts. None of these headwater rivers is capable of supporting numerous large facilities, and, even in combination, they cannot serve all the demands of nearby load centers.

Severe water shortages in southern Florida are associated with minor energy development in competition with large irrigation and urban waste demands.

ORNL-DWG 79-12664

AQCR'S IN REGION IV WITH ONE OR MORE COUNTIES SHOWING NON-ATTAINMENT FOR TSP

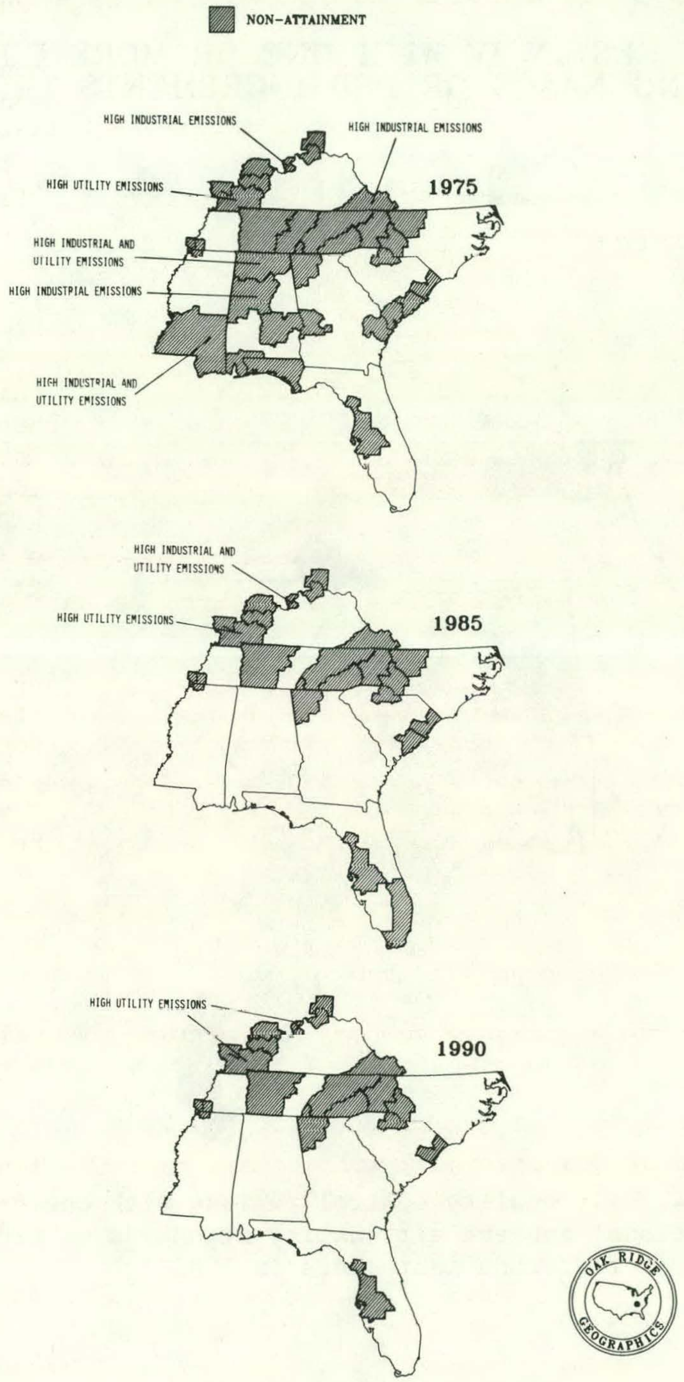


Fig. 4.3. Air quality control regions with one or more counties showing nonattainment for total suspended particulates in 1975, 1985, and 1990.

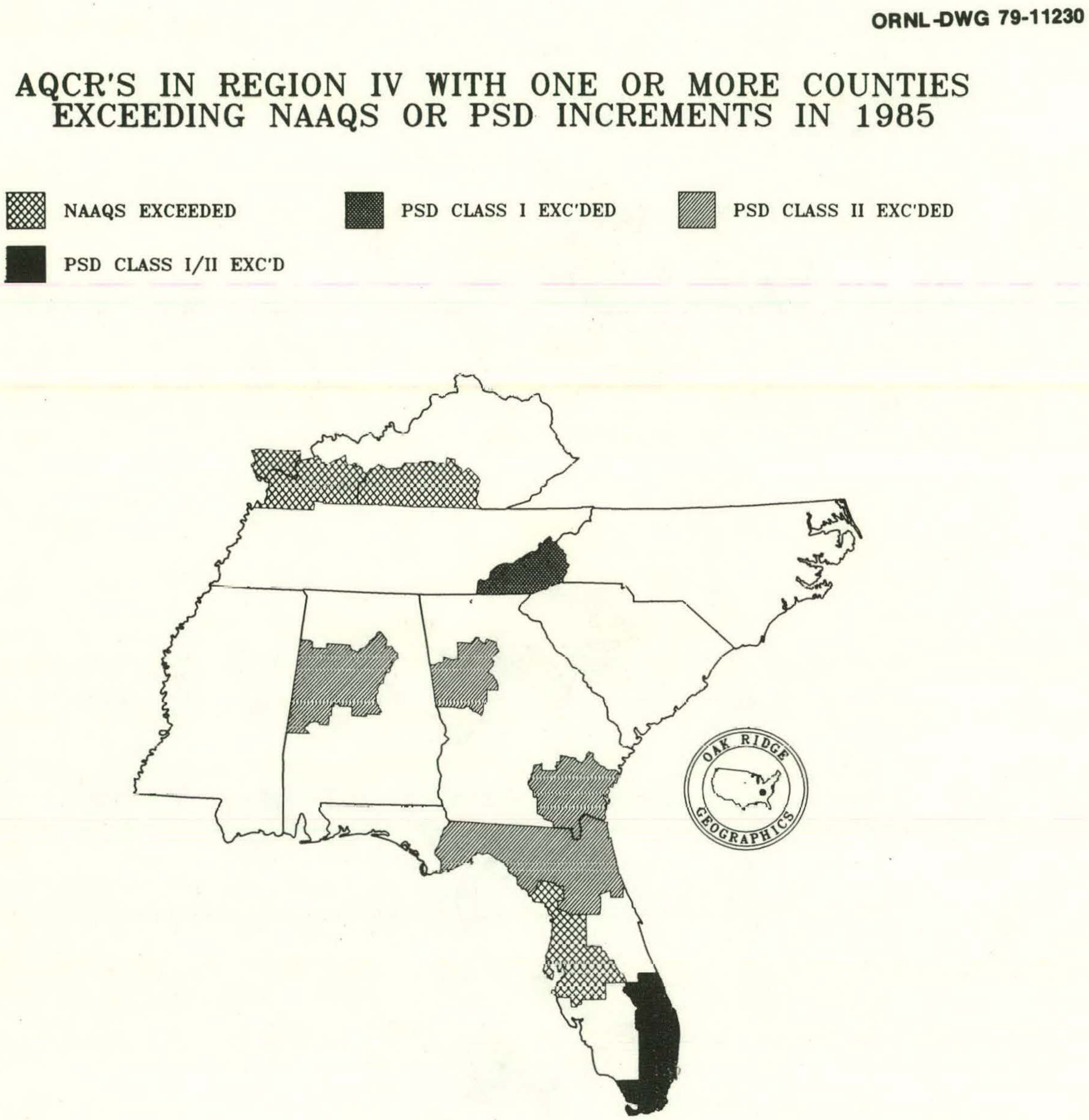


Fig. 4.4. Air quality control regions with one or more counties exceeding national ambient air quality standards or prevention of significant deterioration increments in 1985.

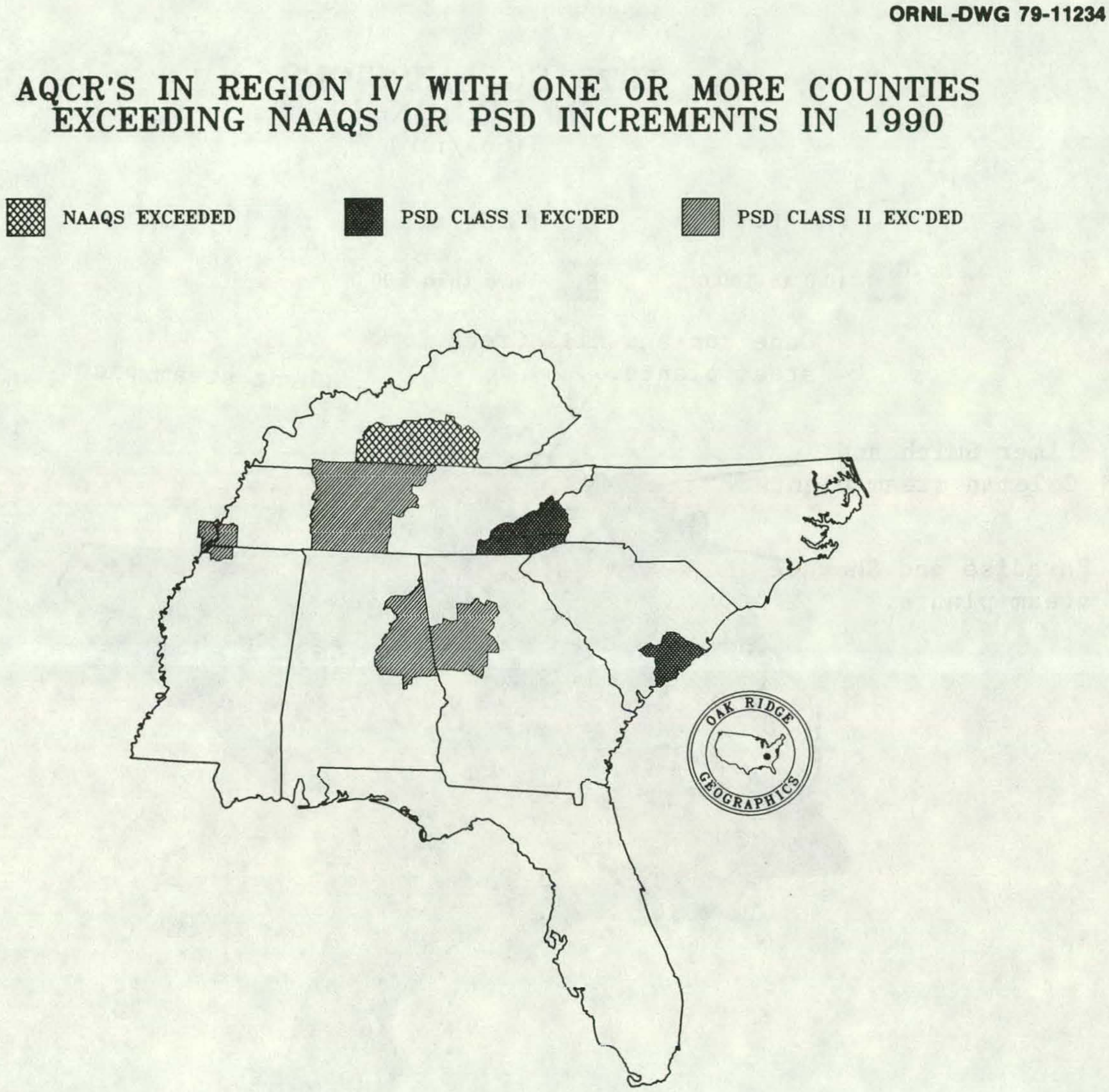


Fig. 4.5. Air quality control regions with one or more counties exceeding national ambient air quality standards or prevention of significant deterioration increments in 1990.

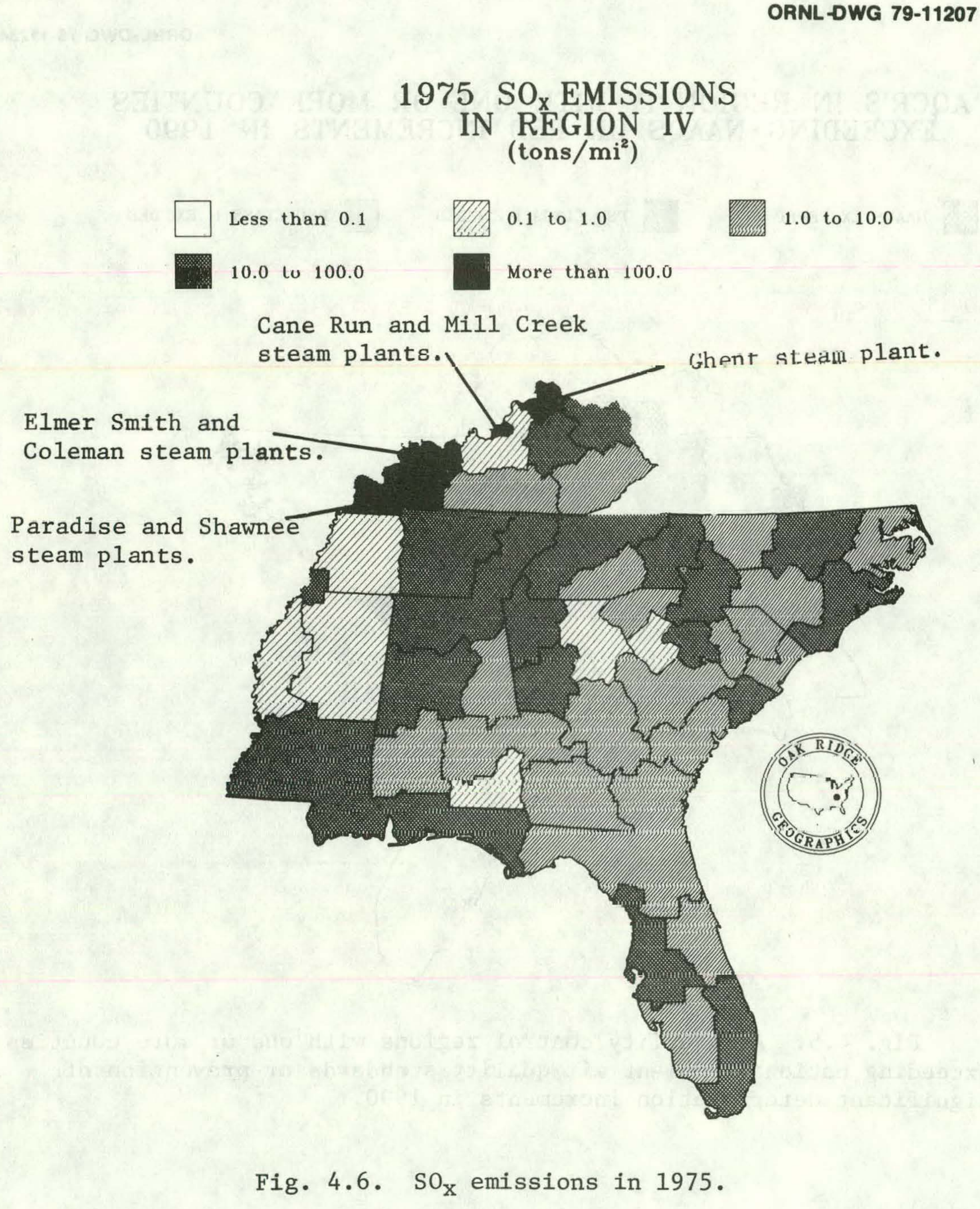


Fig. 4.6. SO_x emissions in 1975.

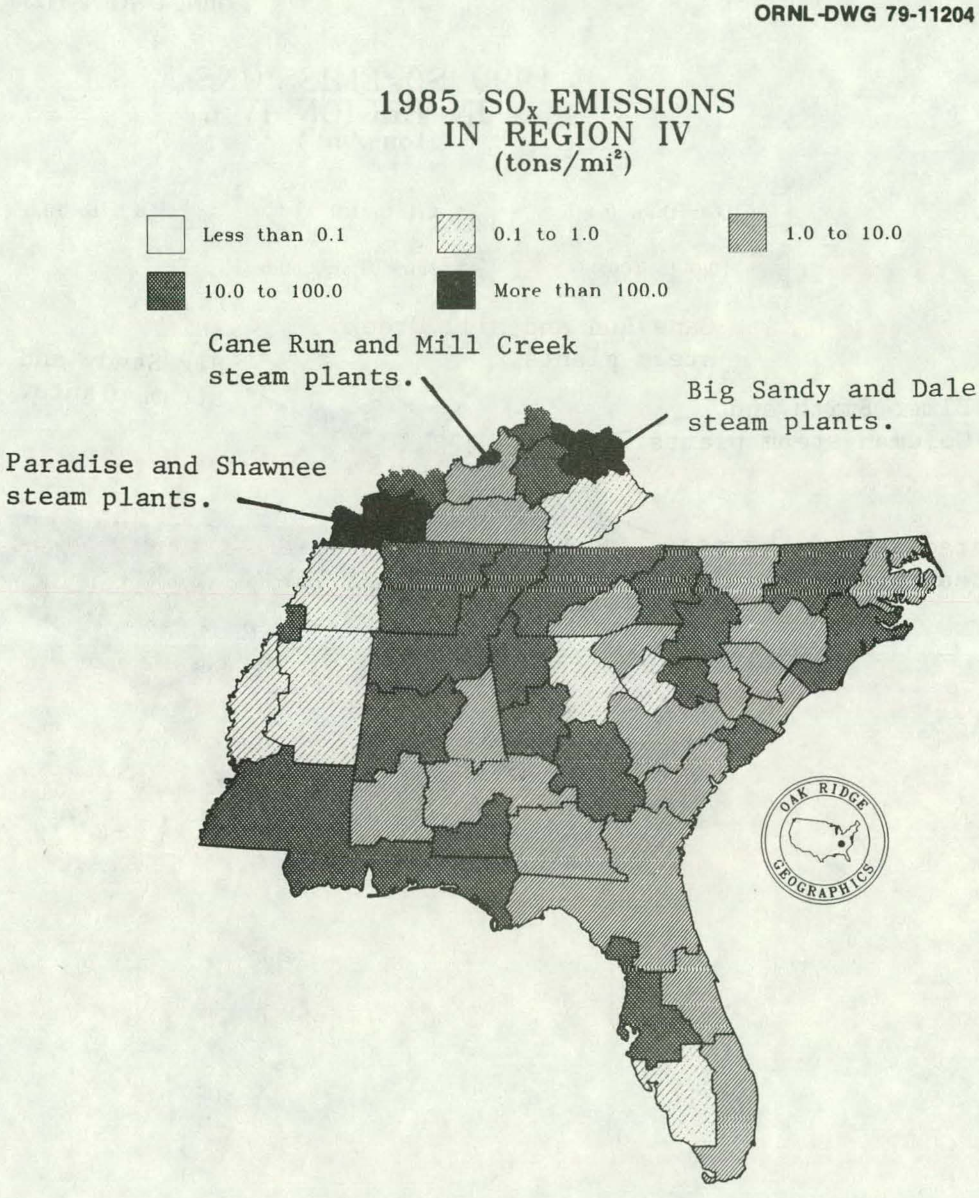


Fig. 4.7. SO_x emissions in 1985.

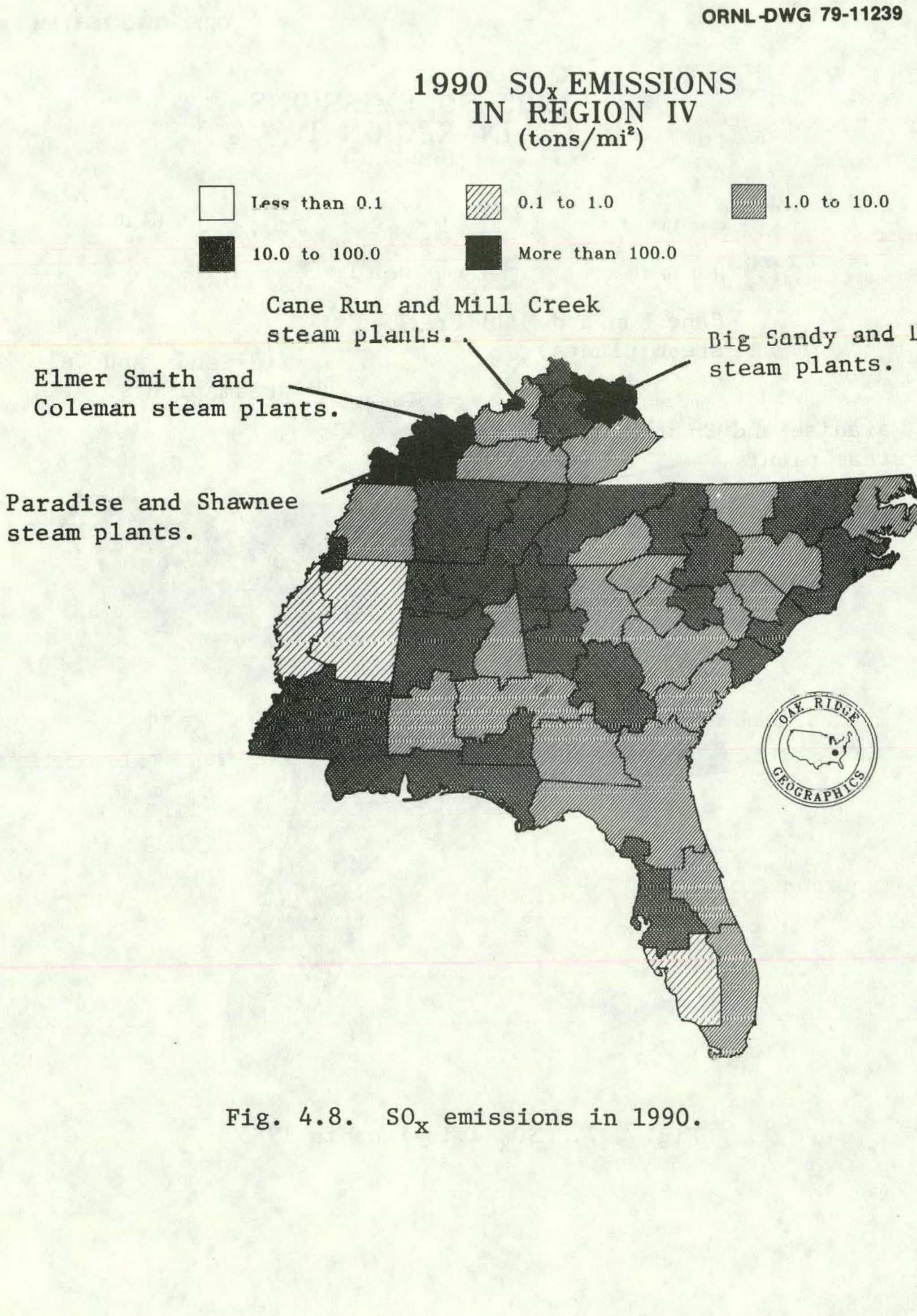


Fig. 4.8. SO_x emissions in 1990.

Table 4.4. Number of counties in each state assessed as having air quality impacts[a]

	PSD Class I increment exceeded[b]		Nonattainment continues for SO_2		Nonattainment continues for TSP[c]		National ambient air quality standard exceeded		PSD Class II increment exceeded		>25% increase in SO_2 emissions[d]		>25% increase in TSP emissions[d]	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Alabama									1	1	1	2		
Florida	1		1		1	1	1	1	2		5	6		
Georgia			1	1					3	1	6	8	2	1
Kentucky					5	5	1				1	3		
Mississippi										1	1	3	1	
North Carolina	1	2			3	2						2	1	1
South Carolina		1			2			1			4	4		
Tennessee					5	3			1	1	2	2		
Total	2	3	2	1	16	11	2	2	7	4	20	30	4	2

[a]County data provided by Argonne National Laboratory.

[b]PSD = prevention of significant deterioration.

[c]TSP = total suspended particulates.

[d]There is no 1975 air quality data.

Table 4.5. Fuel consumption, electric generation, and SO_2 emission in Region IV

Scenario	Coal			Oil			Total		
	SO_2[a]	Electric output (quads/year)	Fuel use (quads/year)	SO_2	Electric output (quads/year)	Fuel use (quads/year)	SO_2	Electric output (quads/year)	Fuel use (quads/year)
1975									
Utilities	5439	0.779	2.269	432	0.261	0.766	5871	1.040	3.055
Industries	566		0.302	564		1.259	1130		1.561
1985									
Utilities (85%)[c]	4040	1.503	4.431	798	0.352	1.038	4838	1.855	5.470
Utilities (90%)[c]	3987	1.503	4.432	798	0.352	1.038	4785	1.855	5.470
Industries	377		0.551	463		1.431	840		1.982
1990									
Utilities (85%)[c]	4452	2.005	5.911	699	0.280	0.825	5151	2.285	6.736
Utilities (90%)[c]	4231	2.005	5.911	699	0.280	0.825	4930	2.285	6.736
Industries	498		0.682	623		1.625	1122		2.307

[a] Emission in 1000 tons per year.

[b] 1 quad = 10^{15} Btu.

[c] Assumed percent control of SO_2 emissions for plants built after 1982.

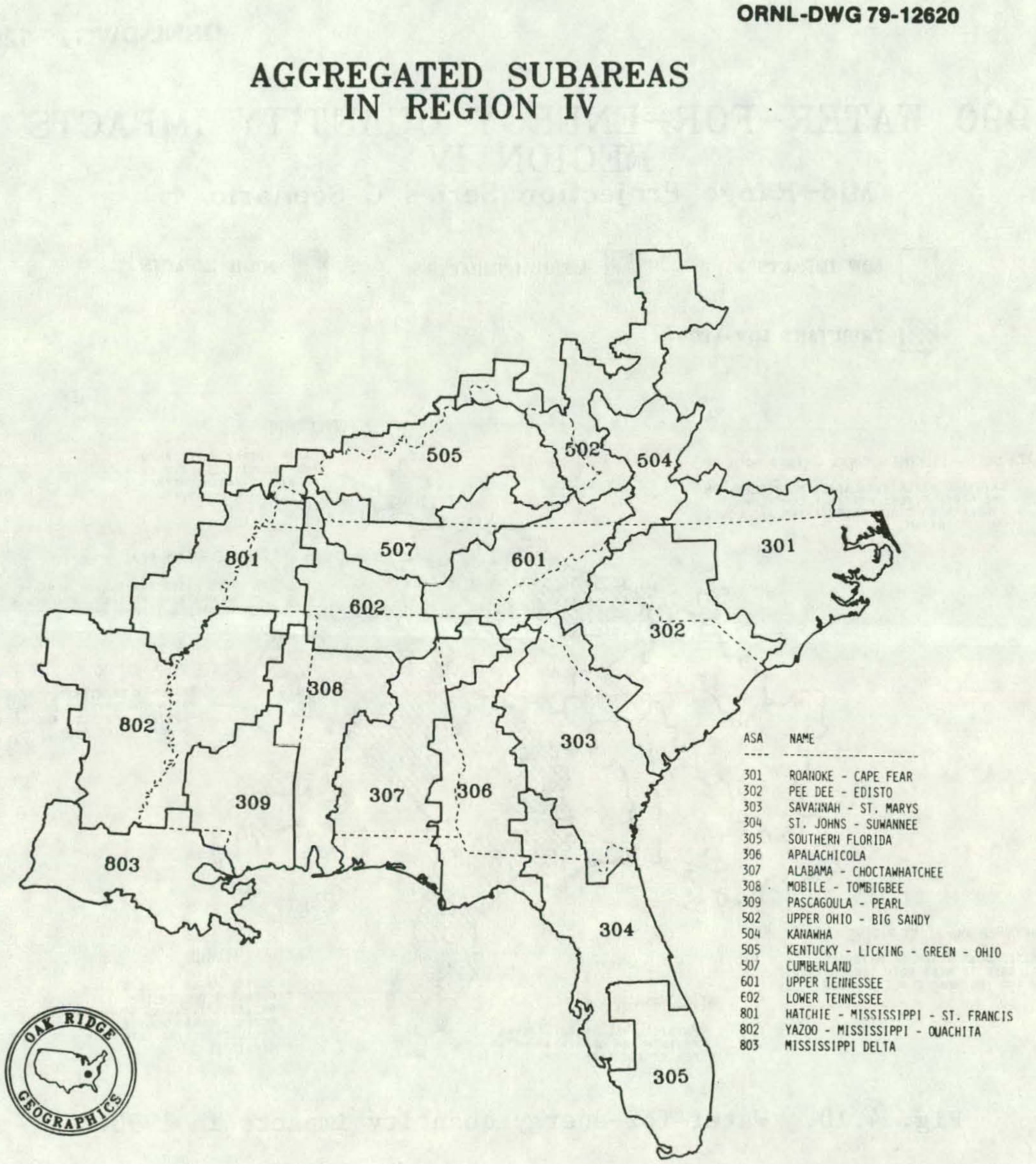


Fig. 4.9. Water Resources Council aggregated subareas in Region IV.

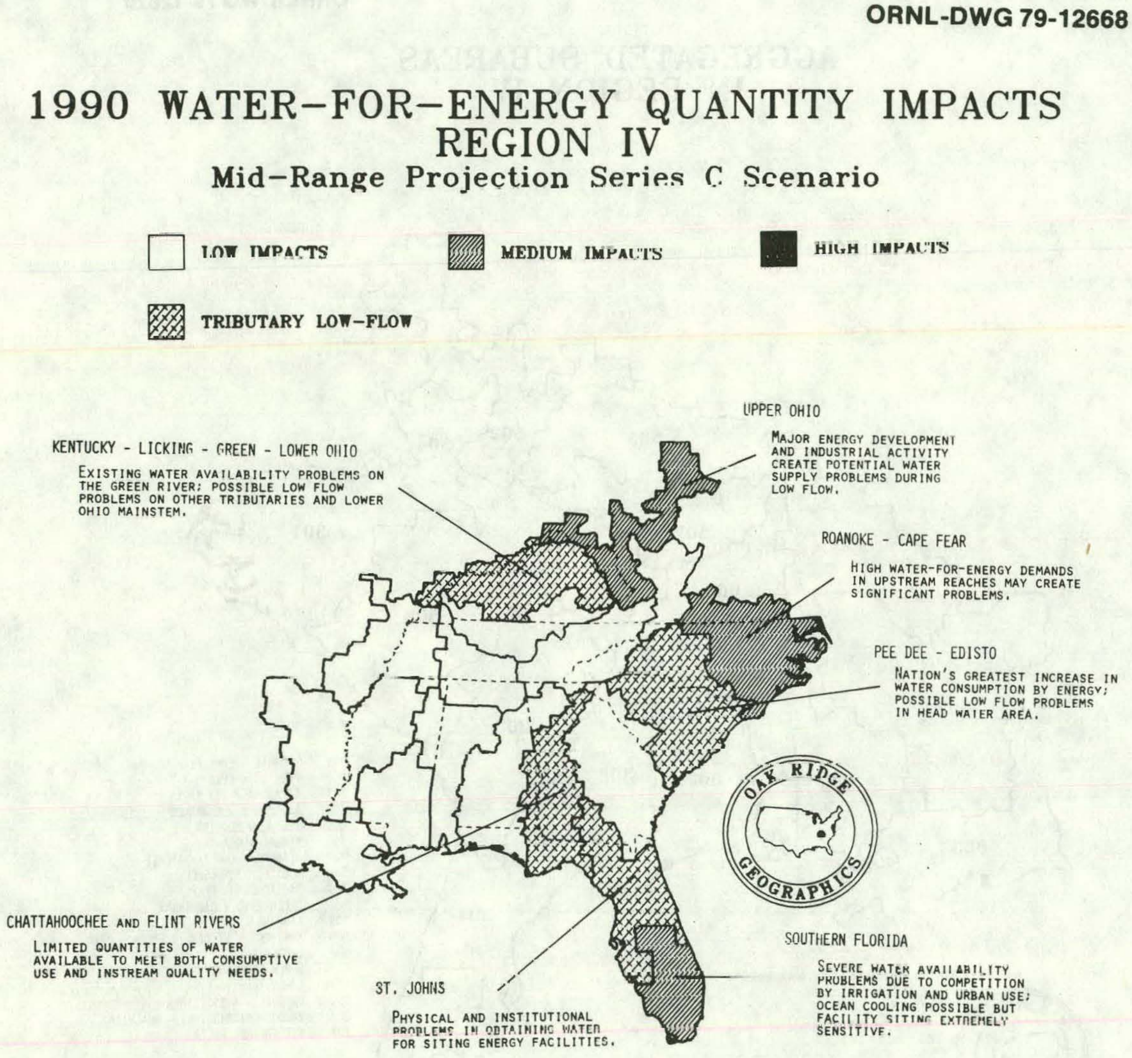


Fig. 4.10. Water-for-energy quantity impacts in 1990.

Substantial local water supply problems not evident at the ASA level are likely to be created by energy development on individual tributaries. Localized problems also are projected for energy during seasonal low-flow periods in the Roanoke-Cape Fear area (ASA 301) of eastern North Carolina and the upper Ohio Basin (ASA 502) in Kentucky.

Few water quality changes at the ASA level are anticipated to result from the energy scenario. The projected water quality impacts are illustrated in Figs. 4.11 to 4.13.

In southern and central Florida utility plant effluents will aggravate existing violations of total dissolved solids and phosphorus criteria. Ash disposal resulting from increased use of coal in Florida and other coastal areas underlain by shallow aquifers may increase the risk of groundwater contamination.

Compliance with coal mining and washing effluent guidelines and surface mine reclamation standards in mining areas should prevent violations and may cause some water quality improvement at the aggregated subarea level. In mountainous areas, however, complete control will be difficult to achieve, and accidental releases and local problems are likely to occur.

4.2.3 Land use, ecology, solid waste

Land use. No major regional land use impacts are predicted for power plant siting requirements to the year 1990. However, major land use impacts are predicted to continue to result from coal mining activities, predominantly surface mining. This is especially true for the state of Kentucky which is predicted to have 175,000 acres directly affected by strip mining by 1990. Alabama and Tennessee expect to have 27,000 and 21,000 acres impacted, respectively (Fig. 4.14).

Ecology. From the information supplied by ANL it appears that major significant environmental impacts will come from coal-related energy technologies. The primary impacts are the result of coal mining and air pollution.[3] Within Region IV the soybean growing areas of Mississippi, Tennessee, and Kentucky on the Mississippi River floodplain and the tobacco growing areas of eastern Kentucky and Tennessee and North Carolina and Virginia (Fig. 4.15) are the most important in terms of potential impacts. In addition, surface mining may affect a variety of endangered species in Alabama (Cahaba shiner, goldline darter), Kentucky (Indiana bat, Virginia Big-Faced bat), and Tennessee (Slender chub, yellowfin madtom, Plateau Musky).

A note of concern also should be expressed relative to the environmental impacts of air pollutants, e.g., SO_2, sulfates, NO_x, and ozone on both crops and natural vegetation. This document only deals with the counties where power plants are located and does not take into account the synergistic problems associated with downwind air pollution from multicounty sources. As indicated in the "National Coal Utilization Assessment for

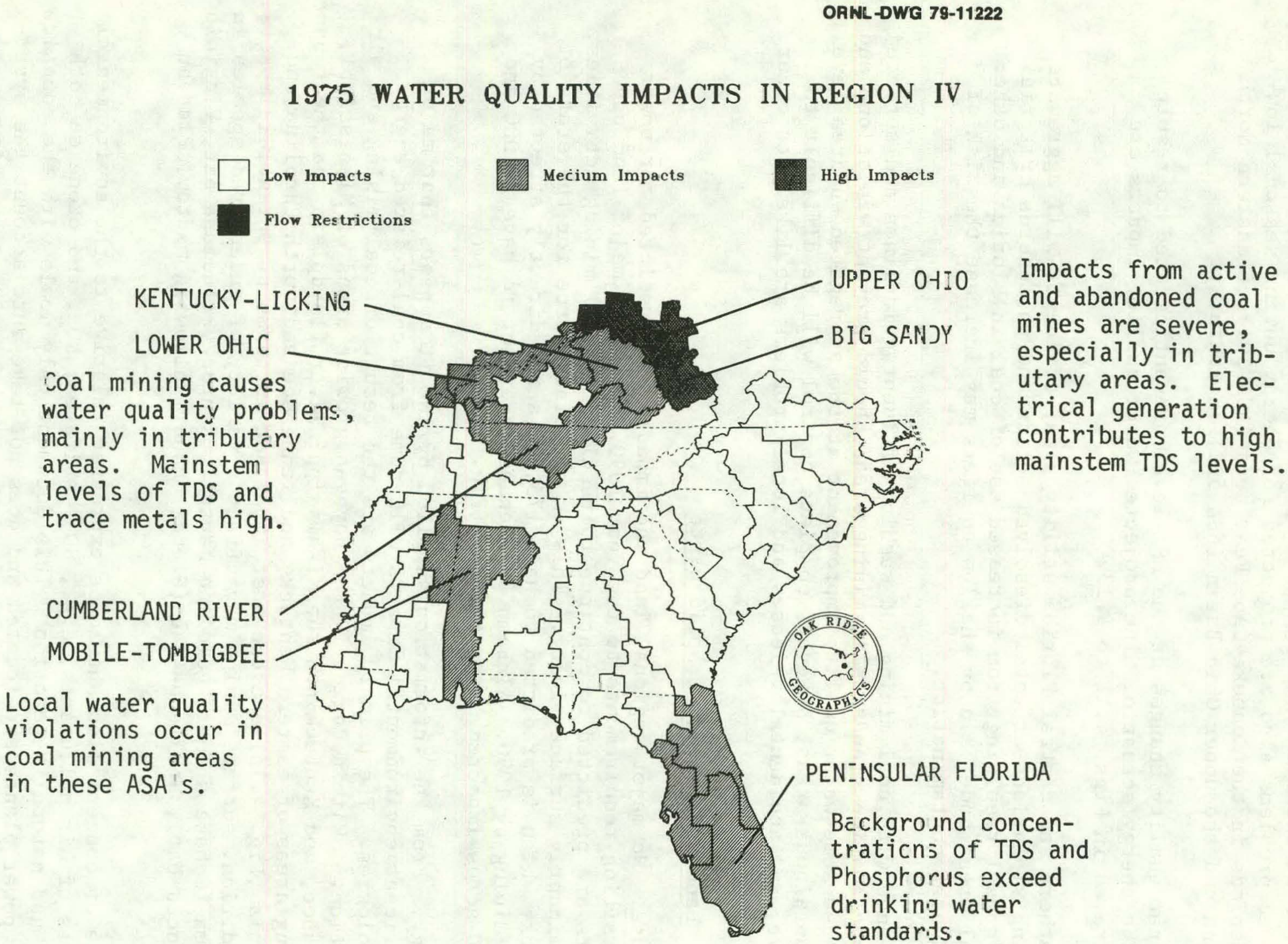


Fig. 4.11. Water quality impacts in 1975.

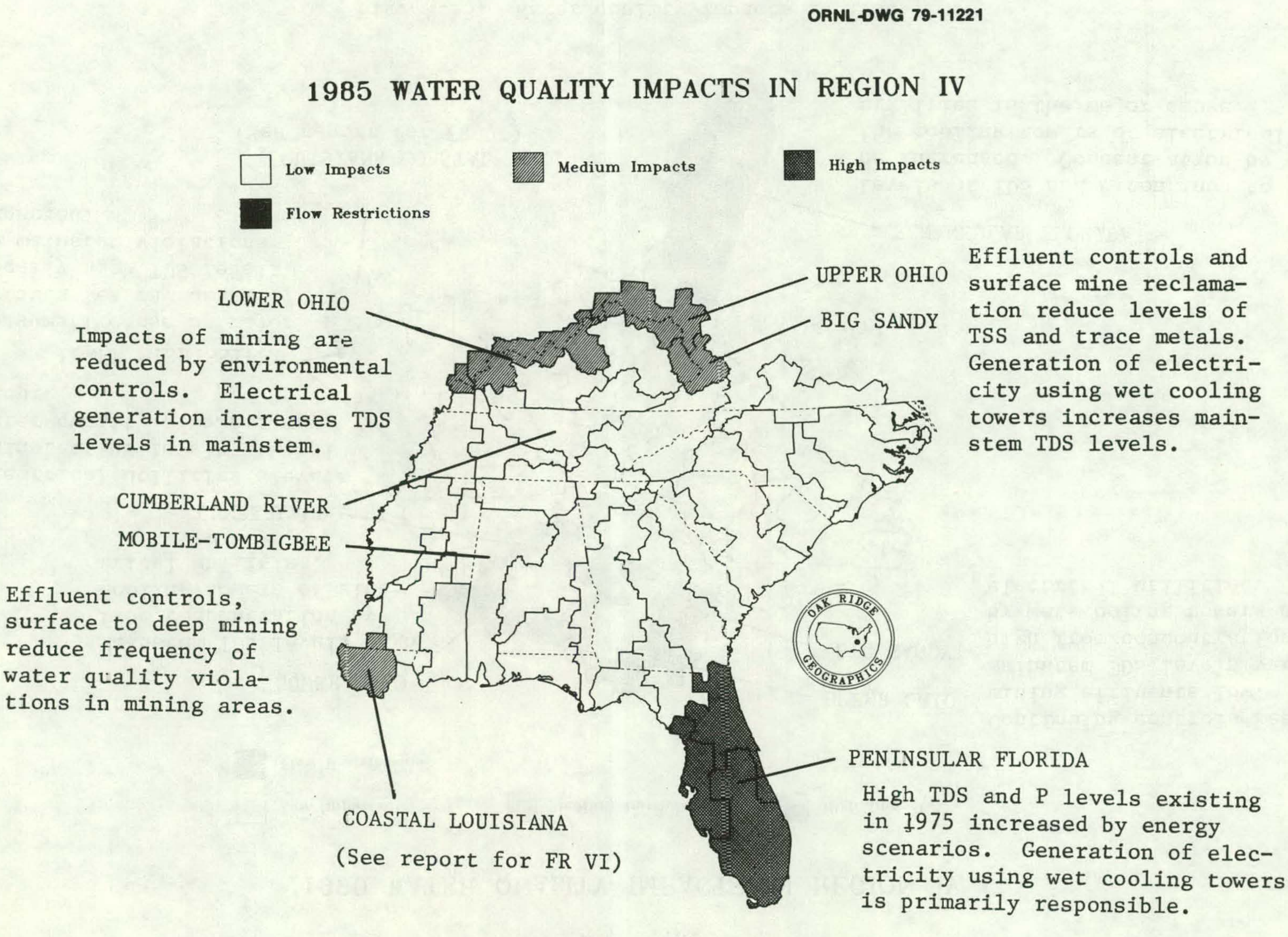


Fig. 4.12. Water quality impacts in 1985.

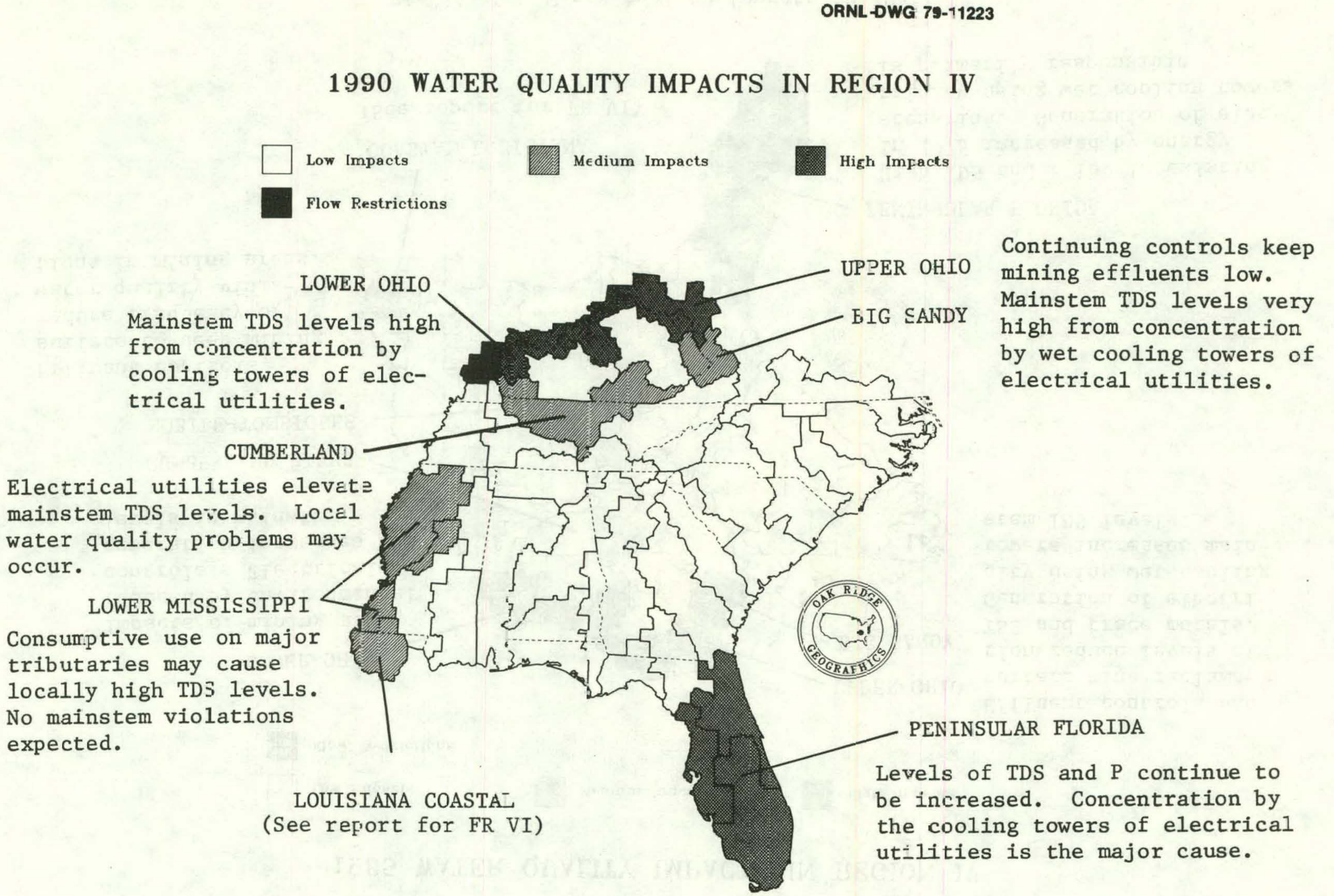


Fig. 4.13. Water quality impacts in 1990.

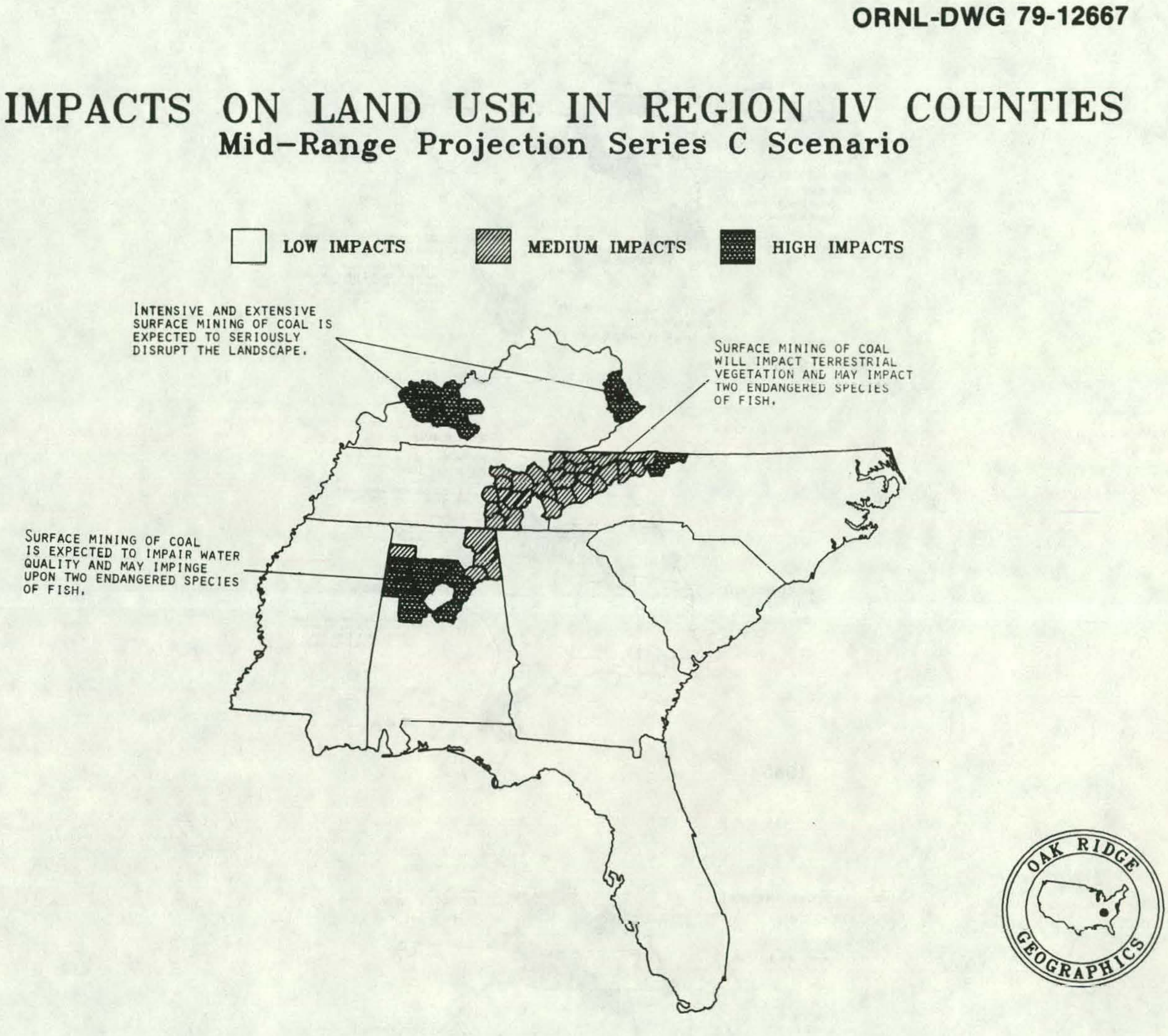


Fig. 4.14. Impacts on land use.

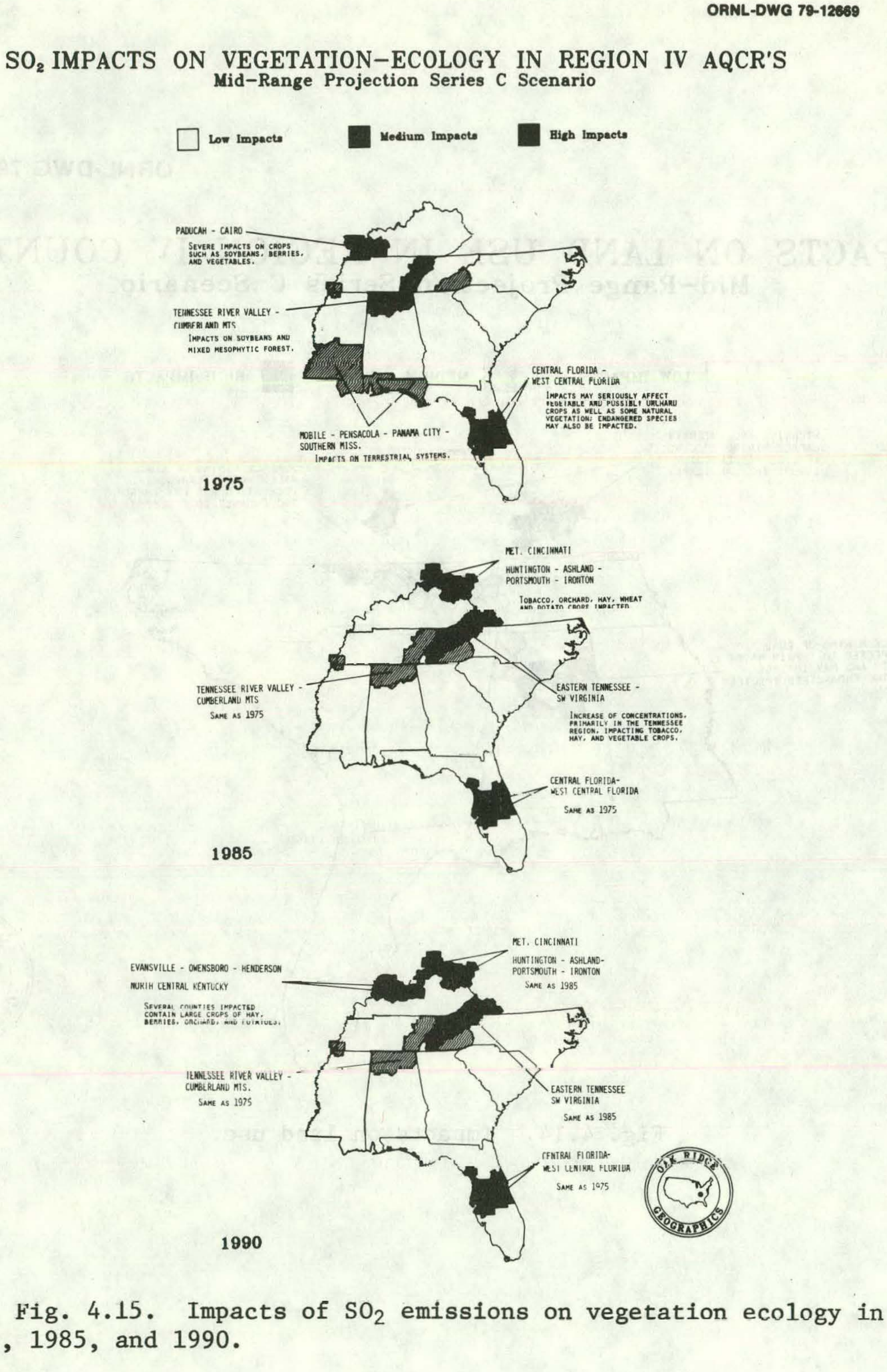


Fig. 4.15. Impacts of SO_2 emissions on vegetation ecology in 1975, 1985, and 1990.

the South."[3] the apparent effects of SO_2 on crops and forests are greater in counties not containing coal-fired power plants. This is because of atmospheric effects distributing pollutants beyond the host county.

Solid waste. Solid waste disposal does not involve a significant scenario impact in Region IV. Of all energy-related activities, strip mining consumes the most land in disposing of solid waste, in this case, overburden. The scenario estimate of solid waste production from strip mining supplied by BNL shows that states in Region IV actually may foresee a decrease in the amount of land disturbed annually over the period 1975 to 1990 due to depletion of resources and shifts to other coal regions.

Potential impacts from increased strip mining may be mitigated by the adherence to contour and reclamation requirements of the new strip mine law (PL 98-87, Federal Surface Mining and Control Act of 1977). Because it appears that the federal government is serious in implementing the provisions of the strip mine bill, it can be assumed that strong enforcement may preclude serious long-term damage to the environment in this area.

Solid waste resulting from the production of energy in power plants and coal conversion facilities is not likely to constitute a major constraint on the deployment and operation of such facilities. BNL projections at the county level show increases in all states but at levels which constitute minimal land impact.

The largest increase in land utilized for solid waste disposal per year occurred in Kentucky. By 1990, 589 acres/year will be consumed by the utility sector for solid waste disposal, an increase of 249 acres/year. Review of the projected siting pattern change between 1985 and 1990 makes this increase seem improbable. More plants are sited on the Kentucky side of the Ohio River than on the Ohio side. Nine plants are projected for Kentucky, most on the Ohio River; only two small plants (one on the Ohio) are projected for Ohio. Apparently the problem is the result of using local siting patterns to satisfy regional demand required by the scenario. Regional demand projections do not recognize the impracticability of siting nine plants on one side of the river and one small plant on the other. In reality, less plant construction is expected in Kentucky and more in Ohio, with resulting smaller solid waste problems in Kentucky.

In any case, the impact of utility solid wastes at the county level will not be severe. The average county in this country has roughly 0.25 million acres, and a power plant is not likely to consume more than 20 acres/year of this. It is interesting to compare utility scrubbers which are expected to produce ∿1 million tons of sludge by 1990 and other activities generating sludge wastes such as municipal sewage which will produce 55 million tons of sludge in 1990 or taconite mining which generated 55 million tons of waste in 1971.

BNL's review of recent utility planning reports indicates that utilities apparently can assemble sites with sufficient acreage for future waste disposal needs.[4] Sites available to utilities have the basic attributes needed for onsite storage. Furthermore, most existing plant sites are large enough to accommodate increased solid waste storage in the event that scrubber systems are required by state regulatory agencies. In effect, it should be possible for utilities to find the land needed to dispose of larger amounts of solid waste in the future.

The existence of sufficient land, however, may not mean the land is available to the utilities. If EPA classifies utility solid waste as hazardous under the Resource Conservation and Recovery Act, utilities will have to overcome public opposition to the presence of hazardous substance in local environments. Concern generated by incidents such as the Love Canal and the Kepone episodes has created a national issue nonexistent a few years ago, and the possibility exists that the public will also be concerned about utility siting. Siting of commercial hazardous waste facilities for industrial use also may be resisted by local groups and could become embroiled in local politics. The situation for a large utility may be different. Utility disposal sites are normally part of the larger site occupied by the plant, under direct control of the utility, and used exclusively by the utility. Furthermore, ash ponds are a recognized accessory to power plants. They do not elicit images of danger in the minds of the public.

Although BNL did not supply information on solid waste generation by coal conversion facilities, the facilities are very similar to coal burning electrical generating plants in their solid waste production and can be lumped with power plants. For example, a solvent-refined coal process coal liquefaction plant of 50,000 bbl/day requires 20 acres/year for solid waste disposal. This is roughly equivalent to a large electrical generating plant.[5] Ten such plants might be on line by 1990, contributing little additional solid waste impact.

Solid waste production from the increased use of coal by industry is small compared to utility output, but it can create local economic impact and environmental issues and frustrate the mandated conversion to coal. Small industries and industries with insufficient land or land unsuited to waste disposal traditionally ship their waste to commercial disposal facilities or release liquid waste directly into the sewer system or a natural watercourse. If industries choose to ship the increased wastes generated by conversion to coal, they will bear relatively high transportation costs. Industry relocations may be hastened by the conversion process, and local economic hardships can be anticipated, particularly in areas that have lost industry in recent times. If industry relies on liquid systems, then they must negotiate with the receiving sewer system over increased loads of dissolved solids. Finally, if solid waste from industrial boilers and pollution control equipment is classified as hazardous waste, the added costs of handling hazardous waste will increase structural and location impacts in local areas.

In summary, solid waste problems stemming from the energy fuel cycles will result in local economic adjustments and produce local political issues. However, solid waste and its associated problems do not pose a significant constraint on acquiring, transforming, and delivering energy at the regional level.

4.2.4 Social, economic, and institutional

Social impacts. Under the Series C Scenario, energy development is projected to occur in 79 of the 736 counties of the 8-state Region IV by 1990. This development is varied and includes 17 nuclear plants, 43 coal plants, 6 oil plants, and coal mining activity in 20 counties. All of the nuclear plants and the majority of the coal and oil plants should be over 500 MWe in capacity. Twenty of the counties with anticipated energy development are expected to experience significant socioeconomic impacts; their population will increase at least 10% from temporary, inmigrant workers and dependents during the construction period as a result of the insufficient supply of skilled labor within commuting distance of the project. Although there are many localized impacts, there should be very little statewide impact during the construction phases of this development. Consequently, no significant regional impacts are expected.

Kentucky is the only state recognized as having the potential for statewide impacts. This potential results from the large portion of the state's present and future economic base generated by coal, not from the effects of a large number of inmovers. Alabama is the only state with no projected significant local impacts. In the region as a whole, only a few localized socioeconomic impacts are expected during the operating phase of these energy developments, primarily as a result of projected increased public spending on services and facilities totaling approximately $1,900,000 annually. The operation phase impacts on either statewide or regional levels should be insignificant, with 6 counties experiencing population increases of approximately 4000 people. The absence of significant regional impacts does not reduce the potential severity of impacts on the local communities to be impacted by energy facilities by 1990.

Direct economic impacts. Under the Series C Scenario, the direct economic impacts of the construction and operation of energy facilities in Region IV cannot be established from data made available for the region. Instead, data for a larger area, the 14-state southern region was assigned to ORNL by DOE: (Region IV plus Arkansas, Louisiana, Oklahoma, Texas, Virginia and West Virginia). Because Region IV is a large portion of this area, considerable economic impact from construction and operation of energy facilities is assumed to occur here, as in the southern region.

The importance of the South's role in the national energy picture is clearly demonstrated in Table 4.6. From financial, employment, and materials standpoints, the contruction and operation of energy facilities located in the South constitute almost half of all such activities occurring in the United States.

Another means of comparing the South's energy role with that of the rest of the country is on the basis of various energy types, as measured by estimated 1975 operating expenses. Such a comparison again indicates the 14-state region's predominance in either generating or supplying energy to the rest of the United States. The South's proportional use of each fuel is depicted in Fig. 4.16. These portions result in a combined total of 51% of the nation's output. It should be noted that this total includes costs of recovering, processing, and transporting energy to regions outside the South.

An additional basis for assessing the energy picture in the South is the region's current and future energy mix as measured by operating costs and employment requirements. Table 4.7 indicates that, under the Series C Scenario, coal, nuclear, and other fuel cycles will undergo expansion, while oil and gas will experience contraction relative to their previous degrees of utilization. In oil, the relative decrease measured in operating costs is moderate and, indeed, on an absolute basis, oil usage actually increases approximately 15% from 1975 to 1990. With gas, the relatives decrease measured in operating costs is approximately 31% over 15 years, and the absolute decrease in gas utilization is approximately 12%.

Two additional important issues for the South are raised by projections of the Series C Scenario. These issues are the availability of skilled construction and operations personnel and the availability of the large amount of capital required to construct projected energy facilities. The scenario calls for a 27% increase in construction man-years and a 36% increase in operating man-years by the 1985-1990 period as compared with 1975 requirements. In respect to financial considerations, the 1985-1990 projections call for increases in both construction capital and operating funds amounting to 30% over 1975 totals. These increases are, in themselves, significant. Assuming continuation of the serious escalations which have been occurring in manpower and financial requirements for energy facilities, it is apparent that potential shortages of skilled employees and national as well as utility-specific constraints on availability of capital could constitute serious barriers to implementation of the Series C Scenario in the South.

Indirect economic impacts. Indirect economic impacts on industrial activity in Region IV of the construction of energy facilities throughout the United States in the scenario can be assessed to a limited degree from the data made available for the 14-state southern region. The economic activity created by such construction will be heavily concentrated in a few sectors of the U.S. economy, as is evidenced in a 368 industrial sector breakdown of the region's economy. The ten industrial categories most affected (in absolute dollars of gross output)

Table 4.6. Total annual costs of constructing and operating energy facilities in the South (percent of total U.S. energy facility costs)

	1975	1976-1980	1981-1985	1986-1990
Construction				
Capital	47	46	46	48
Manpower	47	45	44	45
Resource (materials)	49	48	47	49
Operation				
Costs	51	50	58	46
Manpower	49	48	46	44
Resource (materials)	48	47	45	43

Table 4.7. The South's energy mix (OC/MR)[a]

Fuel cycle	1975 OC/MR	1976-1980 OC/MR	1981-1985 OC/MR	1986-1990 OC/MR
Coal	23/31	26/34	29/37	32/39
Oil	33/31	32/29	31/28	29/26
Gas	29/23	27/21	23/17	20/15
Nuclear	4/1	5/2	5/2	6/3
Other	10/14	11/15	12/16	14/18
Total	99/100	101/101	100/100	101/101

[a]OC = operating costs; MR = manpower requirements.

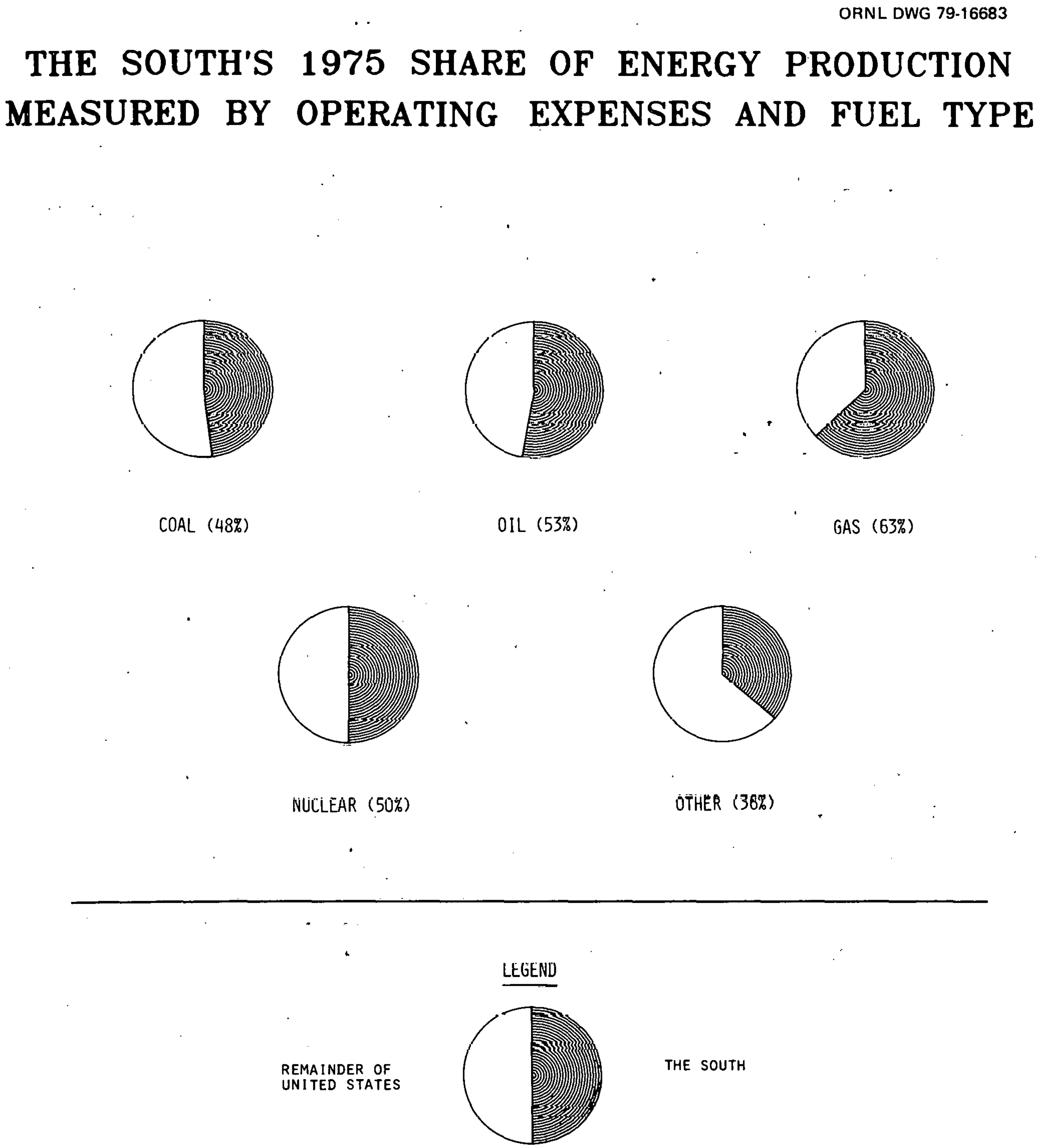


Fig. 4.16. The South's 1975 share of energy production, measured by operating expenses and fuel type.

and the approximate gross output in millions of 1977 dollars for 1976-1980, 1981-1985, and 1986-1990 are indicated in Table 4.8.

The degree of concentration of the indirect impacts is clearly evidenced in the projections that between 37.7 and 38.4% of the Region IV increase in gross output caused by nationwide energy development will occur in the ten sectors in each of the three time periods. Six of these sectors (broadwoven fabric, wholesale trade, real estate, miscellaneous business services, retail trade, and miscellaneous professional services) are not related directly to the energy industry, whereas the remaining four categories (industrial chemicals, basic steel, structural steel, and fabricated plate) are related because they produce components for energy facilities. Note that not a single sector is clearly identifiable as an energy industry. Four sectors — basic steel, fabricated structural steel, fabricated plate, and miscellaneous professional services — will experience particularly significant growth rates.

Of particular note is the fabricated plate category, which will experience an increase in demand of 42.3 to 50.5% of 1972 output. The new output expansion would be distributed fairly uniformly over all the states of Region IV, but such an increase could well be beyond the industry's abilities and could jeopardize fulfillment of the scenario. Some potential difficulties of this type, although of a lesser magnitude, could also arise from increased demand for fabricated structural steel, amounting to between 15.3 to 17.6% of 1972 gross output.

Finally, the coal mining industry in Region IV is well down the list of affected categories in absolute dollar terms and will experience only a modest growth of 2.3 to 2.8% over the actual 1972 gross output during the period of 1976 to 1990.

Institutional issues. Some institutional concerns affect most or all of the states in the federal region. Many were identified at a recent meeting of the Regional Energy Advisory Board of the Southern Governor's Conference. Therefore, rather than repeating them in each state summary, they are listed here, and the more state-specific issues are listed in the state summaries. A few of the general issues appear also in the state summaries when state officials considered the problem especially acute.

- Federal-state-local infrastructure — The relationships among the federal, state, and local governing bodies and the federal regulatory agencies and the efficiency with which they work together are vital to resolving energy problems within the region. Regulatory agencies and state energy offices' roles are being redefined with new legislation. Federal legislation now demands more citizen participation and local input on industrial siting decisions as well as local initiative in many applications for federal funds. Many states do not have effective mechanisms for informing and helping local officials on such decisions. For example, the use of PSD increments

Table 4.8. Indirect impacts on Region IV of the nationwide capital and manpower expenditures for construction of energy facilities[a]

Leading industrial sectors	Sector description	Increase in Region VI's gross output from energy facility construction (millions of 1977 dollars)		
		1976–1980	1981–1985	1986–1990
1601	Broadwoven fabric	143 (1.0)[b]	162 (1.2)[b]	177 (1.3)[b]
2701	Industrial chemicals	150 (1.5)	170 (1.7)	186 (1.9)
3701	Blast furnace; basic steel	209 (7.2)	238 (8.2)	250 (8.6)
4004	Fabricated structural steel	165 (15.3)	172 (16.0)	189 (17.6)
4006	Fabricated plate	445 (42.3)	468 (44.4)	532 (50.5)
6901	Wholesale trade	353 (1.9)	395 (2.1)	415 (2.3)
6902	Retail trade	337 (1.2)	384 (1.3)	420 (1.5)
7102	Real estate	331 (1.9)	374 (2.1)	415 (2.3)
7301	Miscellaneous business services	239 (3.3)	271 (3.8)	302 (4.2)
7303	Miscellaneous professional services	373 (8.3)	423 (9.4)	484 (10.8)
	Total increase of regional gross output for the top 10 sectors	2745	3057	3375
	Total increase of regional gross output for 368 sectors	7225	8099	8799
	Concentration of increased gross output in top 10 sectors	38.0%	37.7%	38.4%

[a]Gross output data provided by Lawrence Berkely Laboratory.

[b]Numbers in parentheses indicate the increase in gross output as a percentage of that sector's regional gross output in 1972, measured in 1977 dollars.

can affect economic development in an area for many years, but local communities do not have sufficient air quality information to make informed choices.[6,7]

- Federal control — Many regulatory areas that were previously state concerns are now controlled by the federal government. This has created problems within the states as to when the limit of federal power will be reached.[8]

- Conflict in priorities and regulations between the national commitment to produce energy and the desire to preserve environmental quality — For example, a conflict exists between the coal conversion sections of the NEA and the Clean Air Act Amendments of 1977.[6-8] There is also the possibility that surface mining regulations may bring about decreases in coal production.[7,8]

- Attitude of officials and citizens and existence of pressure groups within the states toward growth vs no growth, both economic and population — This attitute influences the acceptability and expansion of energy production facilities in the state.

- Inadequate funding for state energy conservation programs.[7]

- Nuclear licensing reform — Concern exists about the time delays in nuclear plant licensing. The Southern Governors' Conference and the National Governors" Association have said that the "states, cooperating in a regional framework, are better qualified than the Federal government to perform environmental review, forecast need for power and site energy facilities."[7,8]

- Need for information by industries on the choice of new technologies and technical and economic problems encountered in converting from gas or oil to coal.[8]

- Comprehensive federal regulatory overview needed for <u>all</u> energy facility siting — The suggestion was made that an agency other than DOE (e.g., EPA or the Department of Transportation) take the lead in developing comprehensive siting plans. Also included in the problem of nuclear waste management which will require new types of federal-state cooperation.[7,8]

- Transportation of coal — The adequacy and safety of railroads, coal haul roads and bridges, and barge facilities is of concern. Although this problem is more acute in the coal-producing states, it is mentioned as a concern for those states with lignite deposits and those turning to coal for electric power generation.[7-9]

- Standards for solar equipment inspection and installation.[8]

- The development of the outer continental shelf — The aesthetic, community, and environmental impacts on the coastal states in the region will have to be examined.[7,8]

- Radiological hazards from coal — Although not considered a health hazard at this time, recent data have shown that the airborne radiation from some coal-fired plants exceeds the allowable radiation from nuclear plants, which operate under another set of regulations. The solid waste disposal potentially poses greater problems and is of concern to the states and the coal industry.[8,10]

4.2.5 Health/safety

Table 4.9 summarizes estimates health effects of air pollution of the scenario for all states in Region IV as projected by BNL. Only a range of possible risk or death is indicated, and caution is advised. The numbers should not be interpreted to be absolute. The range of uncertainty is great.

Employees of Kentucky's numerous energy industries will suffer the greatest occupational death and injury risk in the Southeast. This is largely because of high production from the coal extractive industry and coal-fired steam plants. In addition, the general populace of the state will receive the highest pollutant exposure in the region from combustion of fossil fuel, principally coal. Similar health hazards from fossil fuel combustion are expected to occur in Tennessee, Alabama, and Georgia. Of less importance, but still significant, are deaths and injuries projected to occur among Mississippi's workers in the oil and natural gas fields and oil refineries.

Table 4.9. Estimated mortality resulting from population exposure to fossil fuel combustion products[a]

	Population (millions of people)			Population-weighted concentration ($\mu m/g^3$)			Range of estimated total deaths per year (60% confidence limits)[b]		
	1975	1985	1990	1975[c]	1985[d]	1990[d]	1975[c]	1985[d]	1990[d]
Alabama	3.6	3.9	4.1	9.7	7.1	8.0	170–2800	140–2300	160–2600
Florida	8.4	10.0	11.0	2.2	2.2	2.1	92–1500	110–1800	120–1900
Georgia	4.9	5.6	6.1	8.9	8.0	8.6	220–3500	220–3600	260–4200
Kentucky	3.4	3.8	4.0	21.0	10.0	12.0	360–5700	190–3000	230–3700
Mississippi	2.4	2.4	2.5	3.1	3.8	4.7	36–580	45–730	59–940
North Carolina	5.5	6.1	6.5	7.3	5.9	6.4	200–3200	180–2900	210–3300
South Carolina	2.8	3.0	3.2	7.1	6.2	6.6	100–1600	93–1500	100–1700
Tennessee	4.2	4.9	5.2	14.0	9.6	10.0	300–4800	230–3700	270–4400

[a]Mortality projections developed from Brookhaven National Laboratory damage functions.

[b]Confidence limits based on health damage function only.

[c]1975 SO_4, utility and industrial.

[d]1985 and 1990 SO_4, utility (85% control) and industrial.

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5. STATE ASSESSMENTS

The state assessments provide specific details of the possible impacts of the Mid-Range Projection Series C Scenario in contrast to the regional impacts discussed in Sect. 4. Figures 5.1 to 5.4 illustrate the relative changes in electrical generating capacity by state for 1975, 1985, and 1990. Each state section begins with a summary of the impacts identified for all issue categories. Any major findings are presented at the beginning of each topic by state. Discussion of the institutional/political issues is presented first, followed by discussions of the socioeconomic, water quality/availability, and the land, air, and health impacts. Changes resulting from the conditions in the scenario are discussed in relation to present conditions within the state. Annotated graphics are used where possible to enhance the readers' understanding. Finally, matrices summarizing the magnitude of impacts for each state are found in Appendix A.

Opinions from state officials have been used to help identify potential institutional and political issues. A complete sample of officials was not obtained due to the financial and time constraints of the project. The opinions used may not express the general opinion of all officials, nor the position of the state administration.

5.1 Alabama

Increased combustion of coal in Alabama will have adverse effects on air quality, public health, and possibly vegetation in some parts of the state. The projected switch from surface to deep mining of coal will increase coal mining injuries and deaths. With the exception of these impacts, Alabama should have few other problems in accommodating the changes projected by the Mid-Range Projection Series C Scenario.

5.1.1 Institutional/political issues

- Development of additional nuclear power by a private utility will be mainly dependent on satisfactory adjustment of the electric rate structures by the state.

Existing conditions. Electricity generation in Alabama is supplied mainly by coal-fired plants with some assistance from hydro and nuclear. The state used 1.61×10^{15} Btu's of energy in 1975, and 9% was in the form of electricity delivered to end users. Coal accounted for 44% of the total energy consumed in Alabama in 1975. Alabama does not have a power plant siting law. However, a utility must obtain from the Public Service Commission a "certificate of conversion and necessity" which may contain restrictive provisions.

ORNL DWG 79-14420

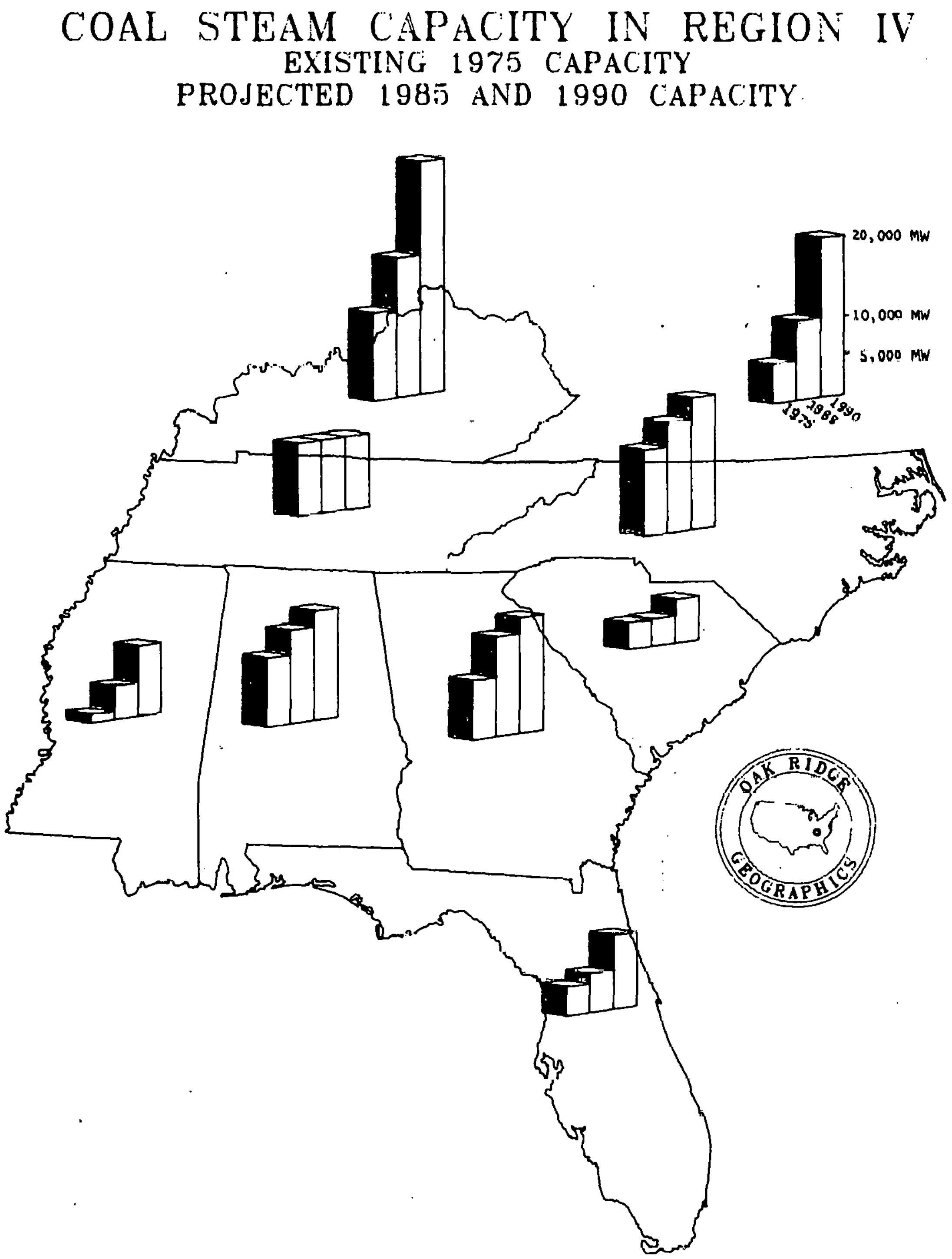

Fig. 5.1. Change in coal steam-electric capacity by state.

ORNL DWG 79-14421

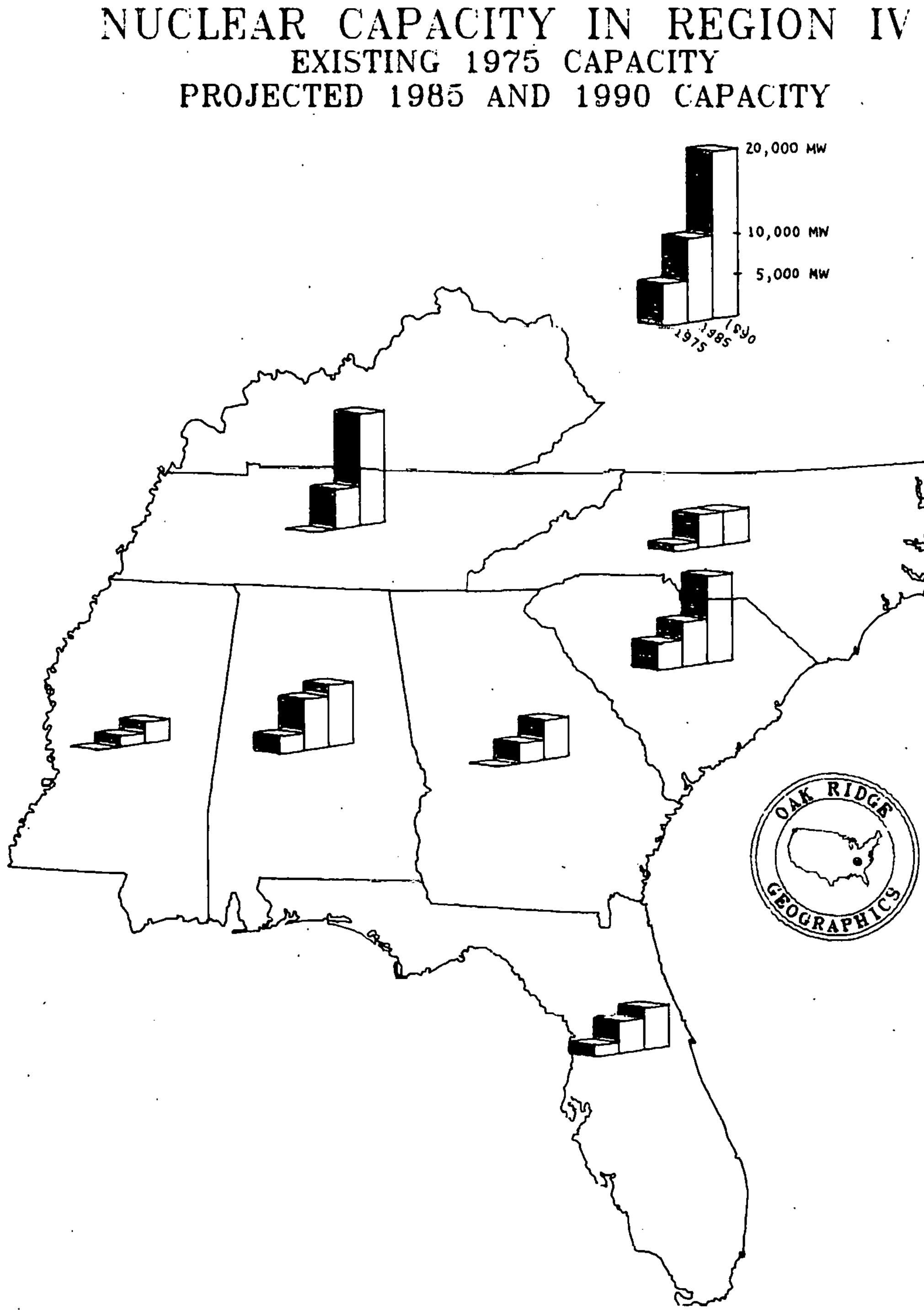

Fig. 5.2. Change in nuclear steam-electric capacity by state.

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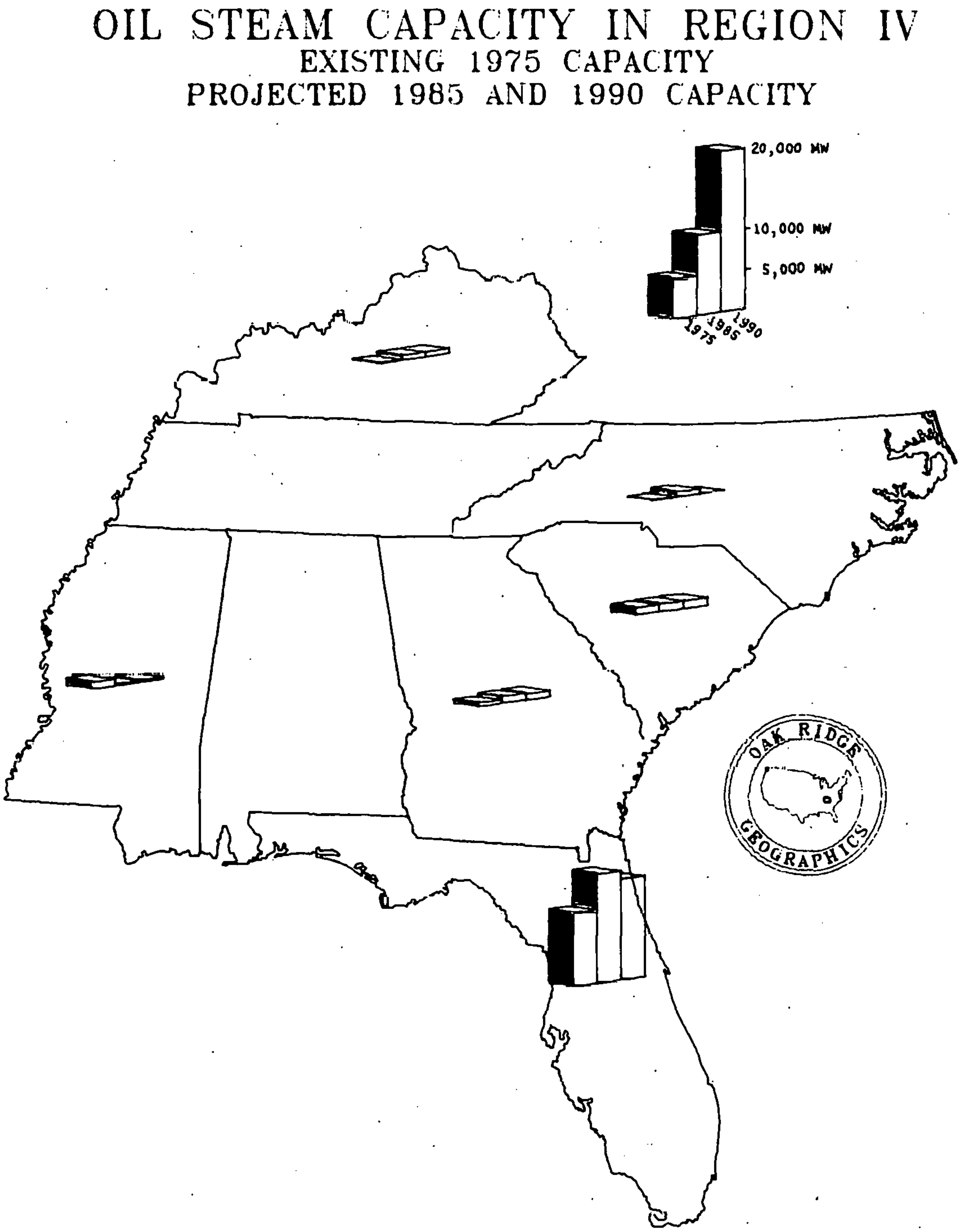


Fig. 5.3. Change in oil steam-electric capacity by state.

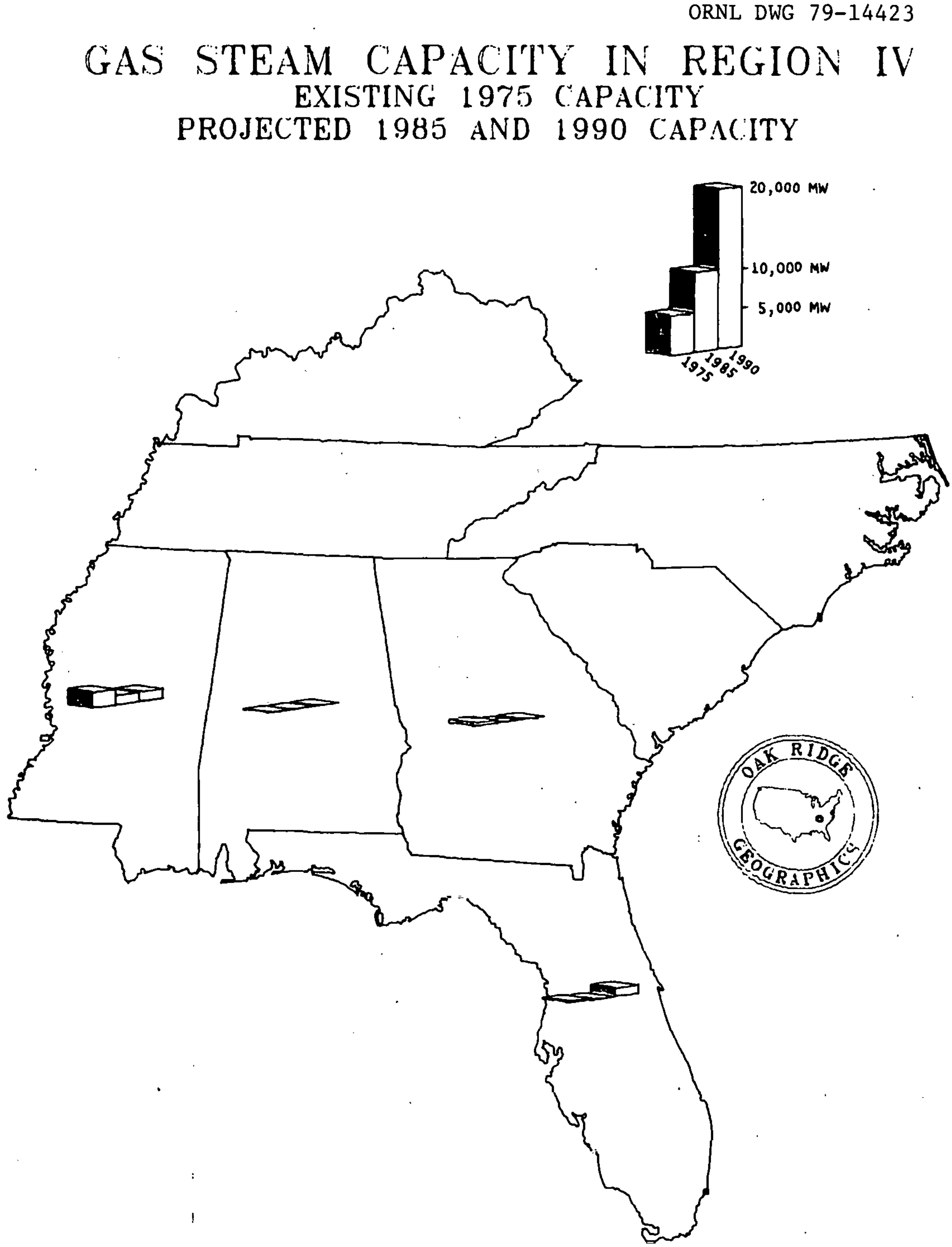


Fig. 5.4. Change in gas steam-electric capacity by state.

Air quality regulations are of concern to Alabama. Officials of the Alabama Air Pollution Control Commission say that the models used by EPA are not applicable at times in Alabama where pollution control from coal-fired plants and state models are not acceptable to EPA. This has created a problem for the state in advising about pollution control measures. These officials also say that the federal regulations regarding ambient air quality in surface mining areas were proposed without consulting the state and may be too restrictive.

Scenario-induced changes. The scenario projects generating capacity in Alabama to more than double by 1990 (from 13,800 MWe in 1975 to 29,200 MWe in 1990) with the increase in nearly equal parts of coal steam, oil peaking, and nuclear (Figs. 5.1 to 5.5). The scenario predicts more coal and oil peaking capacity by 1990 than do the utilities. The scenario and ORNL data on utility projections for nuclear capacity are essentially the same. However, Alabama Power Company has stopped construction on the second unit (860 MWe) of its Farley nuclear power plant because of a dispute over the allowed rate structure. The Tennessee Valley Authority is continuing to build its nuclear facilities. Some opposition is growing to nuclear siting, but in general the legislature has accepted nuclear plants. The impact of the nuclear accident at the Three Mile Island plant on future siting and construction is unknown, and the question of transporting nuclear wastes within the state has not risen.

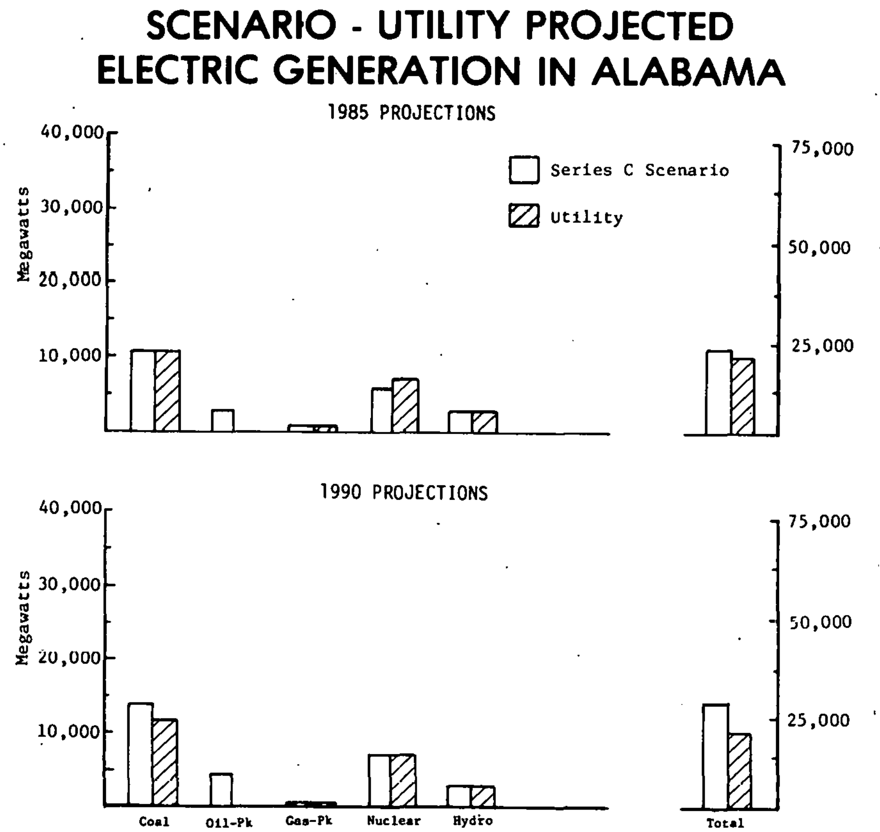
Alabama is a coal-producing state and expects to increase its production by 1985 and 1990. Transportation of the coal is already a problem, and an estimated 30 to 48 bridges and 282 to 359 miles of roadway are expected to be inadequate for coal transportation by 1980. Cost of bridge replacement (1977 dollars) is estimated to be $16,500,000 to $21,450,000; cost of roadway reconstruction and rehabilitation is estimated to be $112,215,000 — 174,820,000. Because numerous sites are available, siting new coal-fired facilities will not be difficult, according to some state officials.

5.1.2 Socioeconomic issues

- No serious impacts are expected at the projected level of growth.

Background. Under the Series C Scenario, energy development is expected to occur in eleven Alabama counties. These counties vary widely in socioeconomic characteristics, although the majority are rural with low population densities and substandard housing. Rural counties will have a lower assimilative capacity for impacts from substantial amounts of in-movers. A county is classified as significantly impacted if it is expected to have one year or more of at least 10% growth in population. This increase is caused by an insufficient supply of basic labor within commuting distance of the plant.

ORNL–DWG 79-16689



ENERGY SOURCE	GENERATING CAPACITY (MEGAWATTS)				
	1975	1985		1990	
	SERIES C	SERIES C	UTILITY*	SERIES C	UTILITY*
Coal	8,658	11,810	11,810	13,810	11,754
Oil Peaking	88	2,989	50	4,682	0
Gas Steam	38	0	38	0	38
Gas Peaking	444	444	444	444	444
Nuclear	2,128	6,096	7,309	7,309	7,309
Hydro	2,472	2,956	2,956	2,956	2,956
TOTAL	13,828	24,295	22,607	29,201	22,501

*ORNL's Data from utility data file.

Fig. 5.5. Comparison of Mid-Range Projection Series C Scenario and utility construction plans in Alabama.

Scenario-induced changes. None of the eleven Alabama counties receiving energy development are expected to experience significant impacts. Many of the counties with large developments, however, should experience increases in the cost of providing public services and facilities.

One county in the Birmingham BEA region is projected to receive project-related population growth of approximately 2,900 during the operating period. Increases in the annual cost of public facilities and services of approximately $1.3 million is also expected.

5.1.3 Water quality/availability issues

- Although the national water quality model anticipates no major changes, the scenario indicates that surface mining in the state will end between 1985 and 1990. This should reduce water quality impacts in the northern Alabama coal counties where steep slopes and abundant, intense rainfall combine to make control of erosion and sedimentation a major problem in both active and inactive surface mines.

- No water quantity problems are evident at the Aggregated Subarea (ASA) level. However, localized problems resulting from periodic drought are likely in headwater areas, particularly around Birmingham, where low-flow levels may limit water availability for consumptive uses.

Existing conditions. Major drainage regions for the U.S. have been delineated by the Water Resources Council. These basins, called ASAs, are shown for Region IV in Fig. 4.9. Alabama contains parts of four ASAs. The Lower Tennessee River (ASA 602) crosses northern Alabama, and the Apalachicola (ASA 306) runs along the southern half of its eastern border. The Alabama River and several smaller coastal rivers (combined within ASA 307), including the Choctawhatchee and Conecuh rivers, drain central Alabama. The Tombigbee and its major tributary the Black Warrior (ASA 308) drain western Alabama.

No existing water availability problems are indicated in Alabama in 1975. Surface waters of Alabama are generally soft (<60 mg/liter calcium carbonate) except for moderately hard water (61-120 mg/liter) in the Tennessee River drainage in northern Alabama. Dissolved solids levels are low (<120 mg/liter) except in the Black Warrior basin, where they are 120-350 mg/liter.[1] Suspended solids levels are low (<50 mg/liter) in all areas except the Tombigbee-Black Warrior and Alabama river basins, where they are slightly higher (51-100 mg/liter).[2]

The Black Warrior River (within ASA 308) drains most of Alabama's coal mining area, and its waters have been affected by the mining. Water quality problems include: acidification by acid mine drainage, usually a local problem in tributary streams; high dissolved solids levels, which often accompany acid mine drainage; and high suspended solids levels resulting from erosion during storms.[3] Both acid mine drainage and sedimentation occur in inactive as well as active mines. Alabama has also reported high suspended solids levels from erosion accompanying silviculture and pesticides from agricultural runoff.[4]

Scenario-induced changes. Mobile-Tombigbee-Black Warrior River Basins (ASA 308). No major changes in water quality and only minimum increases in water-for-energy are expected. The scenario shows a shift from surface to deep mining in Alabama, accompanied by a reduction of suspended solids levels in the Tombigbee-Black Warrior drainage. The national water quality model indicates that total dissolved solids concentrations from all energy activities may increase 126%, with most of the increase attributed to electrical utilities. The resulting stream concentrations will not violate the public water supply criterion (250 mg/liter).

Lower Tennessee River Basin (ASA 602). No significant impacts are expected in the Lower Tennessee Basin. (See discussion under Tennessee.)

Alabama River Basin (ASA 307). The scenario shows few changes in levels of energy activities in the Alabama River drainage, and the accompanying water quality changes are small. Total dissolved solids from electrical utilities will increase slightly, but will remain well below concentrations that would violate the public water supplies criterion (250 mg/liter).

Appalachicola River Basin (ASA 306). No significant impacts are expected along the mainstream of the Appalachicola River in Alabama. However, problems may exist along upstream tributaries. (See discussion under Georgia.)

5.1.4 Air quality/visibility issues

- Air quality will be improved in some instances under the scenario.

Existing conditions. Most of Alabama's current air quality problems occur in the northern part of the state. Parts of the Huntsville metropolitan area violate primary NAAQS for both SO_2 and TSP. In addition, the Birmingham area and northeastern Alabama each have one county in violation of the primary standard for SO_2. In the southern part of the state, only the Mobile area violates the primary SO_2 standard.

Scenario-induced changes. One county in the Birmingham AQCR is expected to violate the PSD increment for SO_2 in 1985 and 1990. Slight reductions are forecast for utility contributions of SO_2 and $SO_4^=$ in 1985 and 1990. There is a two-fold reduction in industrial SO_2 from 1975 to 1985, with a slight increase from 1985 to 1990.

The Sipsey Wilderness area (Fig. 4.2) will be moderately impacted by plume blight from one of the coal units in the seven adjacent counties. The impact is measured as the percent change from 1975 (Sect. 1.2.3).

5.1.5 Land/ecological issues

- Land cover and agriculture may be moderately impacted, according to the scenario, although other analysis indicates that acid rain may be significant by 1990.

Existing conditions. Alabama is primarily divided into three ecological regions: the outer coastal plain in the southern part of the state, the southeastern mixed forest in the central region, and the eastern deciduous forest, including the mixed mesophytic and oak-hickory forests in the north.[5] All three regions contain a number of dominant tree species which are highly susceptible to injury from SO_2, ozone and other coal-fired derived pollutants. There exists in the state approximately 1,290,000 acres of land classified as National Parks, forests, refuges, or other natural areas. At present, there are approximately 72,000 acres in need of reclamation from prior surface mining activities. Reference 6 discusses additional information concerning the present and predicted future impacts of coal mining in the state of Alabama.[6]

Scenario-induced changes. Under the scenario, in 1975 environmental impacts in Alabama from SO_2 are found in only one county (Jackson), which has substantive amounts of soybeans, Irish potatoes, and wheat, and contains significant acreage in mixed mesophytic forest. The impact is expected to decline in 1985 and 1990 as SO_2 levels are to be reduced by more than 50%. However, ORNL's analysis in the National Coal Utilization Assessment[7] indicates sizable areas of this state may be impacted due to increased levels of SO_2, most notably areas of commercial forests and agricultural crops (soybeans). The level of impact has not yet been determined.

Surface mining will have an impact on Alabama; approximately 25,000 acres will be affected in 1985 and 27,000 acres will be affected in 1990. Two endangered species of fish, the Cahaba shiner and goldline darter, are known to inhabit counties where strip mining will occur. These species may be seriously affected by changes in water quality resulting from surface mining activities. Surface mining of lignite in southern Alabama is predicted to increase dramatically beginning in 1980[6] and is expected to account for most of the increase in surface mining.

5.1.6 Health/safety issues

- Accidental deaths and injuries as well as occupational disease incidence in the coal mining industry will be the major occupational health and safety problems. As the surface mining industry decreases, and the more hazardous underground mining industry increases; these health problems will become more serious.
- Expansion of coal electric generation will produce a moderate increase in public health hazard resulting from exposure to fossil fuel combustion products.

Existing conditions. The coal extraction and electric power generation industries present the largest occupational health and safety problem in the state. Of greatest magnitude is underground coal mining, with 1.5 to 5.5 estimated annual deaths and 170 to 620 annual injuries (60% confidence limits). Figure 5.6 shows the estimated distribution of risk from all coal mining in Alabama. Public health effects from exposure to fossil fuel combustion products are considered to be a moderate risk.

Scenario-induced changes. Deep mining occupational hazard is greater than surface mining hazard by a factor of 2 in 1975 (1.5 to 5.5 annual deaths vs 0.9 to 3.0 deaths), rising approximately 5 times by 1985 as strip mine production declines. Figure 5.6 shows the resulting risk for each county. Underground coal mining is the sole source of coal production in 1990. Alabama is second to Kentucky in the region for all coal extraction hazards. Exposure to pollution from fossil fuel combustion is estimated to result in 140 to 2800 annual deaths to the public. This is considered a moderate health risk.[8]

5.2 Florida

The availability of water may limit the energy developments projected by the scenario in southern Florida and, possibly, along the Gulf coast of the peninsula. Increased use of coal in Florida may strain the state's transportation system, increase the risk of groundwater contamination, and in central Florida, reduce fruit and vegetable yields.

5.2.1 Institutional/political issues

- Nuclear generating capacity predicted by the scenario may not be achieved because of utility uncertainty about the costs and construction time.
- There may be equipment and environmental problems associated with the transportation of coal required by the scenario.

Existing conditions. Most of Florida's electricity is generated by oil-fired plants, with assistance from coal, nuclear, and oil peaking facilities. In 1975 the state used 1.8×10^{15} Btu's of energy, and about 13% of this energy was in the form of electricity delivered to end-users. The state is heavily dependent on oil, and in 1975 only 9% of the total energy used was from coal.

Florida air quality regulations are more restrictive than federal regulations, and utilities and the private sector have complained because they cannot purchase adequate amounts of the low-sulfur oil required under current air quality regulations. Because of oil shortages, some state officials think Florida air regulations may have to be relaxed to allow further growth.

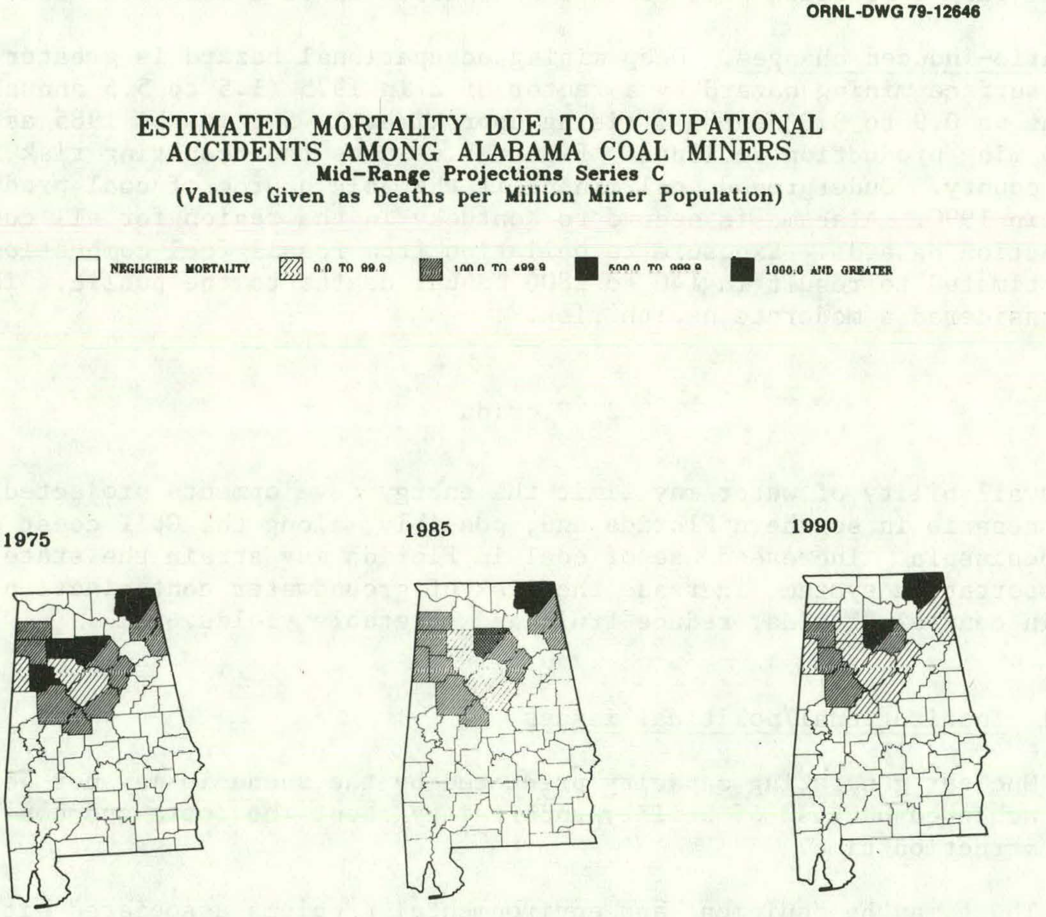


Fig. 5.6. Estimated mortality due to occupational accidents among coal miners in Alabama.

Florida enacted a power plant siting law in 1973 which grants the Department of Environmental Regulation the authority over issuance of power plant siting certificates, with the governor and his cabinet acting as final authority.

Although some communities in Florida have decided to limit growth, there is no strong statewide movement to limit growth, and thus energy demand will continue to rise. However, because of realization of the fragile nature of the environment, more care is being taken by the utilities in siting. A continuing concern is the availability of water and the priorities established for its use.

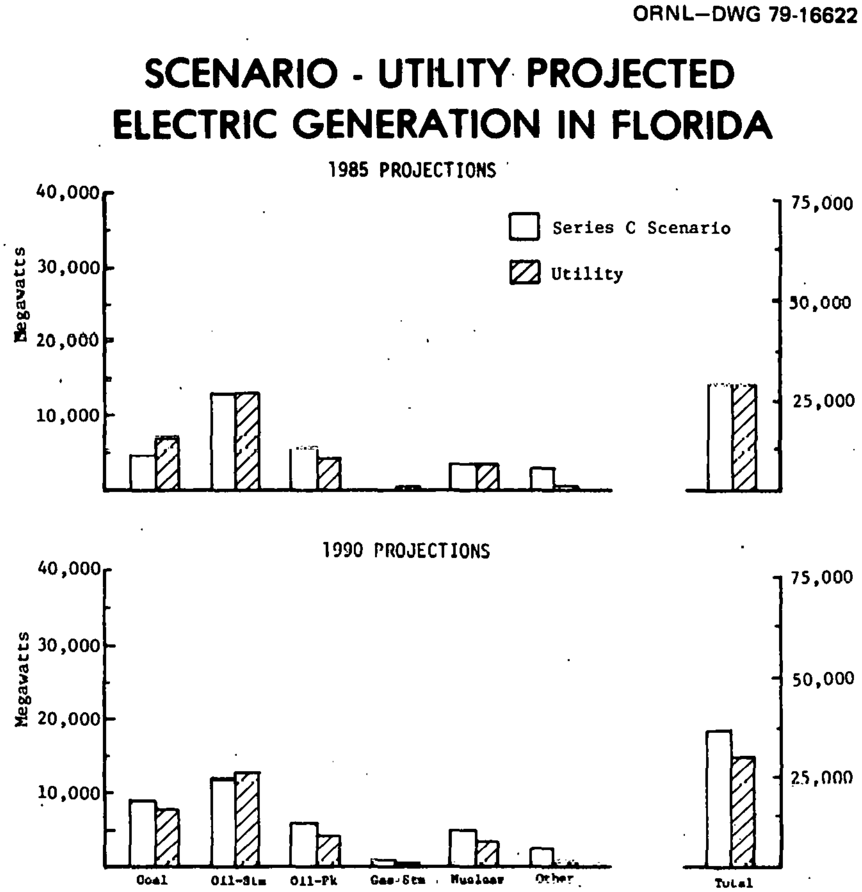
Florida is moving toward use of solar energy in homes and businesses. As a step toward consumer protection in the use of solar energy, the state has established a center for testing and labeling solar system components. A new law will set mandatory solar standards starting in January 1980.

Scenario-induced changes. The scenario requires a doubling of electric generating capacity between 1975 (17,800 MWe) and 1990 (37,500 MWe) with the major increase being from coal-fired plants (2,800 MWe in 1975 to 9,300 MWe in 1990). The scenario predicts more total electric generation by 1990 than do the utilities, and exceeds the utility projections in coal, nuclear (Figs. 5.1 to 5.4), oil peaking, and combined cycle (Fig. 5.7).

Problems identified as a result of the scenario already have been anticipated by the state. The state's transportation, environmental, and coastal zone management agencies are involved in energy facility siting decisions, and no major restrictive legislation is anticipated. There has been no strong support for banning nuclear plants. However, utility projections do not match those of the scenario, and additional nuclear capacity has not been planned because the utilities will not gamble on the delay and cost uncertainties. The impact of the nuclear accident at the Three-Mile Island plant on the additional scheduled nuclear capacity is unknown.

State energy officials note that energy problems also include the environmental impacts such as increased coal dust and coal combustion, the problem of acid runoff from coal storage piles, and acid rain eating into Florida's limestone base. These issues were not addressed in the scenario analysis.

Transportation of coal and oil may be a problem. The rail beds, particularly those in adjoining states, may not be adequate for increased shipment of coal. A bill may be introduced into the state legislature providing for right of emminent domain for coal slurry pipelines, to ease the burden on rail and ports. Oil spills in ports and the Florida straits could cause major damage to the commercial fishing and tourist industries. In the opinion of state officials, the ports have fairly good emergency plans in case such spills do occur.



ENERGY SOURCE	GENERATING CAPACITY (MEGAWATTS)				
	1975	1985		1990	
	SERIES C	SERIES C	UTILITY*	SERIES C	UTILITY*
Coal	2,788	4,934	7,758	9,341	8,183
Oil Steam	9,843	13,544	13,699	12,514	13,799
Oil Peaking	3,648	5,896	4,253	6,939	4,253
Gas Steam	195	0	150	1,030	128
Nuclear	1,332	3,761	3,761	4,901	3,761
Hydro	30	30	30	30	30
Comb. Cycle	0	2,734	484	2,734	484
TOTAL	17,836	30,899	30,135	37,489	30,638

*ORNL's Data from utility data file.

Fig. 5.7. Comparison of Mid-Range Projection Series C Scenario and utility construction plans in Florida.

5.2.2 Socioeconomic issues

- Significant socioeconomic impacts from the construction of energy facilities are projected for one Florida county. This impact would be the result of an insufficient supply of available labor required to meet peak construction demand within commuting distance of the plant. This county would experience a strain on public and private services and facilities because of the influx of large numbers of construction workers.

Background. Under the scenario, energy development is expected to occur in 17 Florida counties. Approximately one-half of these counties are very rural with low population densities while many of the others are highly urbanized. Rural counties will have a lower assimilative capacity for impacts from substantial amounts of in-moving workers.

Scenario-induced changes. Of the 17 counties expected to receive energy development, only one county, in the Tallahassee BEA region, is expected to experience significant impacts (Fig. 5.8). This county should experience at least one year of population growth greater than 10% from the construction of a coal plant, a projected peak work force requirement of approximately 1,800, and a total of approximatley 1,800 in-migrants, including dependents. The other 16 counties are not expected to experience significant impacts.

The highly impacted county should experience, at construction peak, an increase in the cost of providing public services and facilities of approximately $950,000. Many of the other counties also should have large increases in these costs.

One county, in the Orlando BEA region, is projected to experience project-related population growth of approximately 256% during the operating period. Increases in the annual cost of public facilities and services of approximately $140,000 are also expected.

5.2.3 Water quality/availability issues

- Effluents from the utility and industrial sectors may aggrevate existing water quality problems (total dissolved solids, phosphorus) in central and southern Florida (ASAs 304 and 305). The projected tripling of utility coal use between 1975 and 1990 will increase the risk of groundwater contamination from coal handling and ash disposal, a serious consideration because the state is largely underlaid by shallow limestone and unconsolidated sand and gravel aquifers.

- Southern Florida (ASA 305) has shortages during low-flow periods due to extensive irrigation, and any increase in water consumption is likely to conflict with current needs. The flat terrain and permeable soil preclude reservoir construction in most of the area, and excessive pumping of groundwater tends to reduce surface flow

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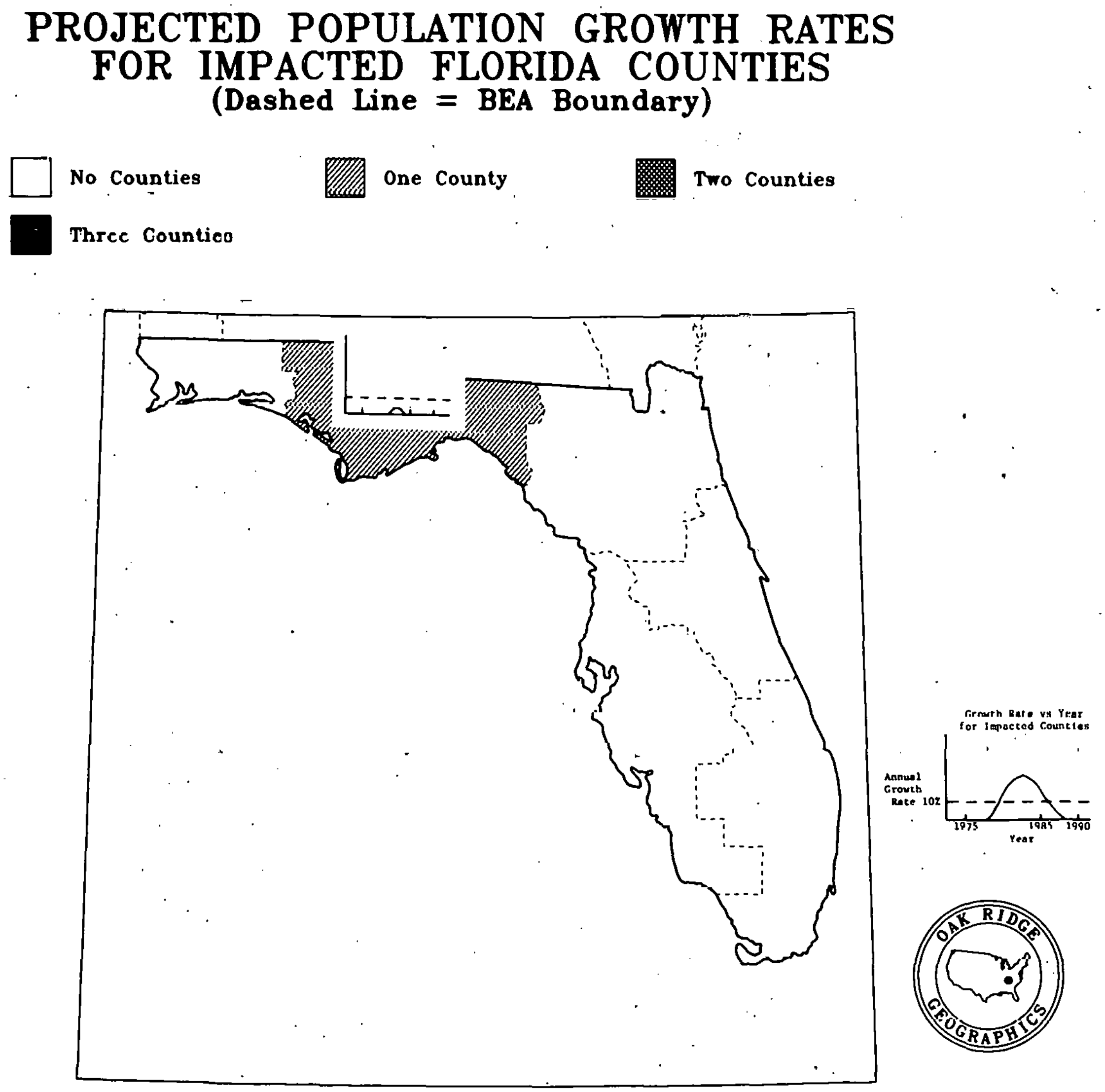

Fig. 5.8. Projected population growth rates for impacted counties in Florida.

or cause intrusion of salt water into aquifers. Cooling with saline water is preferred, but coastal areas are highly valued for recreational, residential, and ecological purposes and use of this technology is expensive.

- Possible low-flow problems are also indicated in the St. Johns-Suwannee area (ASA 304), although no major energy development is projected. Conflicts in obtaining water for energy facility siting presently exist in the St. Johns Basin, and similar problems may hinder development elsewhere in the state.

Existing conditions. Florida contains all or part of five ASAs, though each of these areas is drained by a number of separate streams rather than one major river. The western panhandle (ASA 307) receives drainage from southern Alabama, and contains the mouths of the Choctawhatchee and Conecuh Rivers and other smaller streams. The eastern part of the panhandle (ASA 306) receives the Appalachicola River from western Georgia, and smaller coastal drainages. Northern Florida (ASA 304) is drained by the St. Johns River to the east and the Suwannee River to the west, although numerous other streams drain both sides of the central peninsula. The St. Mary's drainage is included with the Savannah River (ASA 303). The southern Florida area (ASA 305) has no single major drainage.

Peninsular Florida's water quality is different from that of the other south Atlantic states. It ranges from moderately hard in the north to very hard (181 to 250 mg/liter calcium carbonate) in the south. Although dissolved solid levels in the Florida panhandle are generally <120 mg/liter, in southern Florida they range from 250-500 mg/liter, and in the St. Johns River they can reach 500-1000 mg/liter. Suspended sediment levels are low throughout the state, generally <50 mg/liter.[2]

Background levels of total dissolved solids in peninsular Florida often equal or exceed the 250 mg/liter limit suggested for public water supplies. Nitrogen and phosphorus levels are also high throughout the state. Sources of pollution include municipal and industrial wastes as well as drainage from agricultural areas and urban runoff.[4]

Florida's coastal waters have been polluted by dredge-and-fill operations in wetlands. Some electrical generation in Florida uses salt water for cooling, adding thermal pollution to the other impacts caused by the high population densities along the coast.

Scenario-induced changes. Appalachicola (ASA 306) and Alabama (ASA 307) River Basins. The Panhandle area (ASAs 306 and 307) contains the mouths of several large- to medium-sized rivers. The activities forecast by the scenario are not expected to cause any significant water quality or availability impacts.

St. Johns River-Suwannee River-Tampa Bay (ASA 304). The emissions to water in ASA 304 come almost entirely from electrical generation facilities. Very little increase in generating capacity or change in water quality is predicted for the Suwannee River Basin. Utility plants sited in the area drained by the St. Johns River and in the Tampa Bay area, where most of the new facilities are expected in Florida between 1975 and 1990, will face both physical and institutional water availability conflicts. The already high total dissolved solids concentrations from energy facilities may increase from 169 mg/liter in 1975 to 422 mg/liter in 1990. Phosphorus concentrations from energy facilities may rise as much as 18%, from 0.16-0.18 mg/liter. Existing background violations of both constituents would be increased.

Southern Florida (ASA 305). Projected increases in industrial fuel use alone may cause significant increases in total dissolved solids and phosphorus levels, which already violate water quality criteria for the surface waters of Southern Florida (ASA 305). Utility use of fresh water for cooling would cause additional water quality problems, but the water supply is so limited, and competition by irrigation and urban uses so severe, that additional ocean cooling may be the only option available. Ocean cooling, however, also poses problems because coastal areas are highly valued for other purposes, and siting new generating facilities on the coastline of peninsular Florida will require great care.

5.2.4 Air quality/visibility issues

Existing conditions. Air quality is good over most of Florida. The SO_2 levels in the Tampa, Jacksonville, and Orlando areas are high, but the EPA has cited only one county, in the Tampa area, for nonattainment of the primary SO_2 standard. Parts of these three urban areas also violate the secondary standard for TSP.

Scenario-induced changes. One county in the Miami area is expected to exceed the PSD Class I increment in 1985, and two counties in the Jacksonville and Palm Beach areas are expected to exceed the PSD Class II increment. The NAAQS will be exceeded in only one county, in the Tampa area, in 1985 and 1990.

The Chassahowitzka Wilderness (Fig. 4.2) will experience a low plume blight impact from oil steam units in 1985 and 1990 located within the county. One of five adjacent counties will produce a high plume blight impact from oil steam in 1985 and 1990. A similar situation exists in the Everglades National Park. Oil steam and oil peaking units in adjacent counties (two of the three adjacent counties) and a park county will produce a low to high plume blight impact in 1985 and 1990. There are no significant regional haze impacts projected to affect Class I areas in Florida in 1985 or 1990.

5.2.5 Land/ecological issues

Existing conditions. Most of Florida lies within the outer coastal plain forest ecoregion dominated by the beech, sweetgum, magnolia, pine, and oak forest; the everglades province occupies the southern tip of the state.[5] A number of forest tree species in the coastal plain forest are senstive to SO_2 and sulfates. The agricultural lands of the state are well documented as being a large source of citrus fruits and vegetables. There currently exists no energy resource extraction in Florida, aside from uranium by-product extraction involved in the phosphate mining located in the western central region of the state.

Scenario-induced changes. Florida has three counties expected to be impacted from SO_2 pollution (Duval, Hillsborough, and Polk). The crops which are expected to be impacted are berries, vegetables, melons, and (possibly) orchards. Southern mixed forest can also be expected to be impacted with no significant changes in SO_2 levels occurring between 1975-1990. Within these counties a number of endangered or threatened species are known to be present. These include the manatee (whose critical habitat occurs within the region), American aligator, and red-cockaded woodpecker. The short-tailed snake, a species currently being reviewed as potentially endangered, also inhabits the region. It is not known how SO_2 may affect these species. However, one can speculate that SO_2 pollution may possibly affect the red-cockaded woodpecker as it requires old, mature pine trees for its nesting sites.

5.2.6 Health/safety issues

- Occupational injuries and accidental deaths among oil production workers are expected to increase dramatically with the projected expansion in oil production.

Existing conditions. Annual deaths and injuries from oil production in Florida (0.6 deaths, 55 injuries) and Mississippi (10.7 deaths, 62 injuries) were the highest in the region in 1975. Estimated occupational hazards from oil electric generation in the region were highest for Florida workers (0.12 annual deaths and 11.2 annual injuries). With no coal production in 1975, health effects from coal electric generation are among the lowest in the region.

Scenario-induced changes. Estimated annual deaths and injuries from oil production in Florida are among the highest in the region in 1975, but gradually fall to third position by 1990 as Mississippi and Alabama oil fields fulfill their projected expansion.

Florida and Mississippi's natural gas production is projected to remain high through 1990. Projected death and injury rates parallel production (0.1 deaths and 9 to 12 injuries for Florida, and 0.1 to 0.2 deaths and 8 to 20 injuries for Mississippi).

Estimated occupational hazard from oil-fired electric generation parallels increases in capacity for Florida. Health effects in Florida and Mississippi resulting from fossil fuel combustion should remain the lowest in the region through 1990 (92 to 1900 and 26 to 940 annual deaths, respectively).

5.3 Georgia

New utility construction in southern Georgia will have significant socioeconomic impact upon five rural counties in that part of the state. Water availability in headwater streams near Atlanta may limit urban and energy growth by 1990. Otherwise, the scenario will have little significant impact on Georgia's water resources.

5.3.1 Institutional/political issues

- Institutional/political issues are not expected to restrain energy development in Georgia.

Existing conditions. Georgia currently generates most of its power from coal, with some hydro, nuclear, oil peaking, and oil and gas steam (Fig. 5.4). In 1975 the state used 1.3×10^{15} Btu's of energy; and about 11% was in the form of electricity delivered to end users. Georgia does not have a power plant siting law, although a study committee of the state legislature has examined the possibility of such action to simplify the laws and regulations which currently pertain to siting.

The state has little fossil fuel reserves and consequently has encouraged development of solar demonstration projects including biomass. However, if more use is made of solar power, state officials anticipate problems arising as to impacts on utility rate structure and on the construction industry.

State officials believe that the federal and state authorities have a reasonable working relationship. There are few state and local government problems in energy matters. Local governments have a great deal of authority in land use under the Georgia "Right of Local Home Rule" legislation.

Scenario-induced changes. The scenario projects an increase in electric generation from 11,700 MWe in 1975 to 29,000 MWe in 1990. The major increase will be in coal, nuclear, and oil peaking facilities (Figs. 5.1 to 5.4). The total generation projected by the scenario is considerably greater than that of the utilities. The differences are mainly in projections for coal, nuclear, and oil peaking capacity (Fig. 5.9).

The opinion of some state staff is that siting of new coal-fired power plants may be influenced by air quality constraints. Large installations also require a surplus water permit issued by the state. A new law regarding state permits for radiological wastes also exists. The impact of the accident at Three-Mile Island on future nuclear plant construction is unknown.

Because coal generating capacity is predicted to almost double between 1975 and 1990, state officials anticipate some problems with trucking and railroads for delivering coal. New state legislation requires

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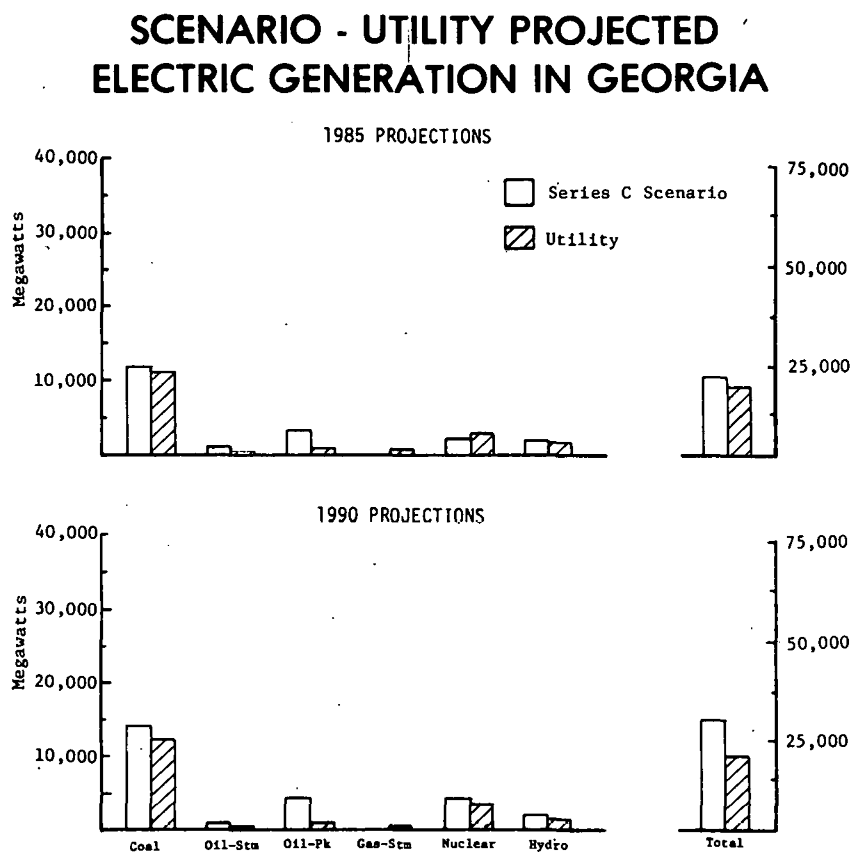

ENERGY SOURCE	GENERATING CAPACITY (MEGAWATTS)				
	1975	1985		1990	
	SERIES C	SERIES C	UTILITY*	SERIES C	UTILITY*
Coal	7,520	12,612	11,891	14,612	12,716
Oil Steam	446	827	546	827	546
Oil Peaking	1,095	3,752	1,095	4,784	1,095
Gas Steam	353	0	355	0	235
Nuclear	786	2,389	2,753	4,689	3,903
Hydro	1,479	1,991	1,741	1,991	1,741
Comb. Cycle	0	450	0	450	0
Pumped Stor.	0	887	1,137	1,668	1,137
TOTAL	11,681	22,908	19,518	29,021	21,373

*ORNL's Data from utility data file.

Fig. 5.9. Comparison of Mid-Range Projection Series C Scenario and utility construction plans in Georgia.

permits and advance notice for shipments of nuclear materials. The intent, is not to restrict nuclear shipments but to reassure the populace.

5.3.2 Socioeconomic issues

- Significant socioeconomic impacts from the construction of energy facilities are expected for five counties in Georgia (Fig. 5.5). These impacts should result from an insufficient supply of available labor required to meet peak construction demand within commuting distance of the plant. These counties should experience a strain on public and private services and facilities from the influx of large numbers of construction workers.

Background. Under the scenario energy development is expected in six Georgia counties. These counties are predominantly rural and therefore have a low assimilative capacity for impacts from substantial amounts of in-moving workers.

Scenario-induced changes. Significant impacts from nuclear plant construction are expected in one county in the Augusta BEA region and one county in the Savannah BEA region (Fig. 5.10). Coal plant construction should cause significant impacts in one county in the Macon BEA region and two counties in the Savannah BEA region.

In these counties, the projected noncoincident peak work force requirements range from approximately 1600 to 3600 people. Inmigration, including dependents will range from 1800 to 6000 people during the peak construction year.

One county in the Atlanta BEA region is not expected to experience significant impacts from the construction of a coal plant. This county's projected population increase during construction is less than 10%.

Two counties planning nuclear plants will experience, at construction peak, large increases in the cost of public services and facilities of approximately $1.9 and $3.1 million. The other significantly impacted counties should experience increases from approximately 1.0 to 1.7 million.

No county is expected to encounter impacts during the operation phase of these plants.

5.3.3 Water quality/availability issues

- No major water availability constraints or quality changes are apparent at the ASA level. However, Atlanta is situated at the headwaters of several small rivers which are currently experiencing local water quality and low-flow availability problems. Even in combination, these upstream tributaries will not be able to support all of the city's needs near the load center.

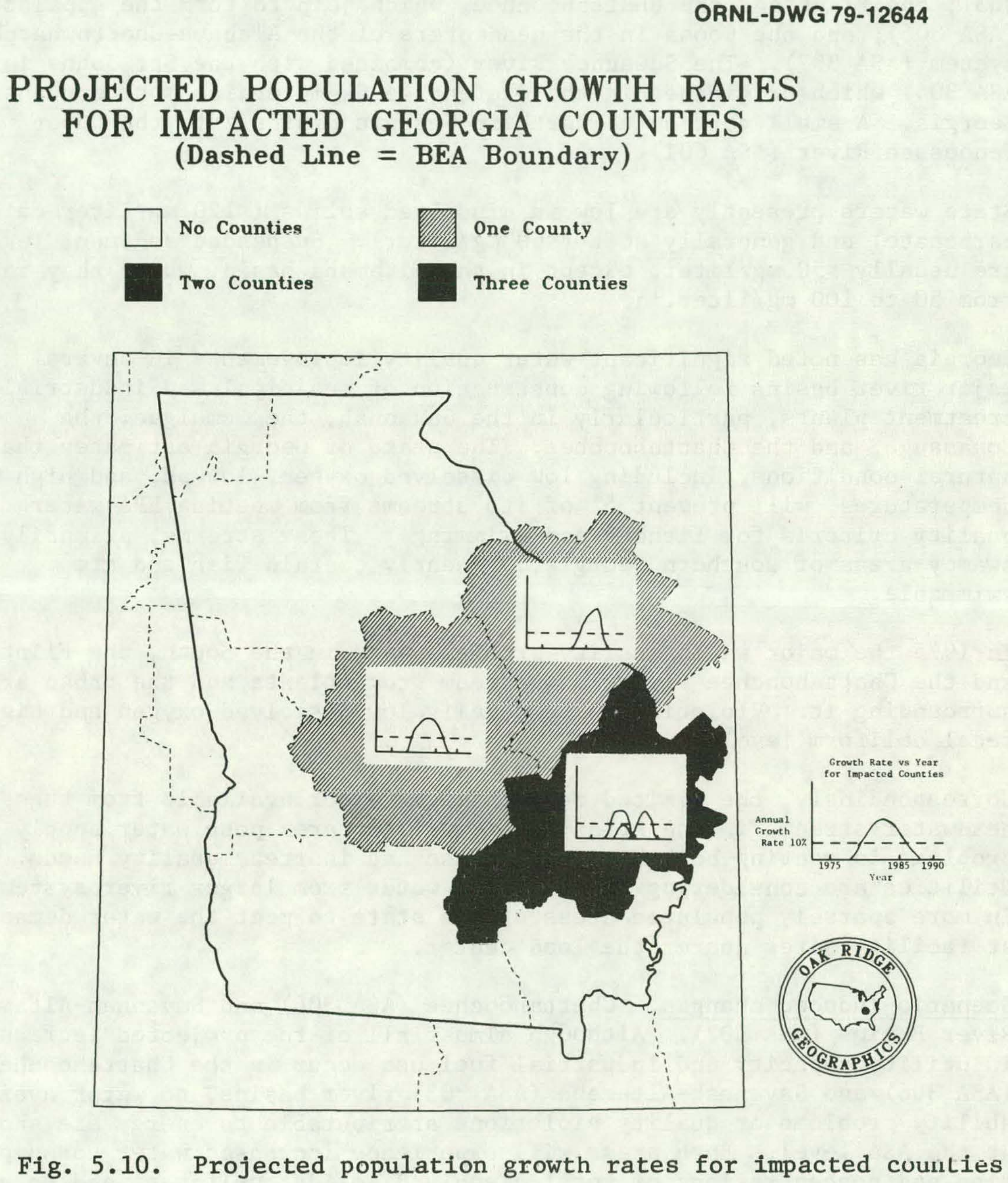

Fig. 5.10. Projected population growth rates for impacted counties in Georgia.

Existing conditions. Most of the state is drained by four major river systems originating in the mountains of northerncentral Georgia (Fig. 4.9). From east to west, they include the Savannah along the eastern border, and the Altamaha (both are combined with the St. Mary's in ASA 303); the Flint and the Chattahoochee, which join to form the Appalachicola (ASA 306); and the Coosa in the headwaters of the Alabama-Choctowhatchee system (ASA 307). The Suwannee River (combined with the St. Johns in ASA 304) which originates in the Okefenokee Swamp drains southerncentral Georgia. A small portion of northern Georgia drains into the Upper Tennessee River (ASA 601).

State waters presently are low in dissolved solids (<120 mg/liter calcium carbonate) and generally soft (<60 mg/liter). Suspended sediment levels are usually <50 mg/liter, except in the Altamaha basin, where they range from 50 to 100 mg/liter.[1,2]

Georgia has noted significant water quality improvements in several major river basins following construction of municipal and industrial treatment plants, particularly in the Savannah, the Ocmulgee, the Conasauga, and the Chattahoochee. The state of Georgia estimates that natural conditions, including low dissolved oxygen, low pH, and high temperatures, will prevent 5% of its streams from meeting EPA water quality criteria for fishing and swimming.[4] These streams, primarily in swampy areas of southern Georgia, presently contain fish and are swimmable.

In 1975 the major water quality problems were in the South, the Flint, and the Chattahoochee rivers downstream from Atlanta and the urban areas surrounding it. Violations were usually low dissolved oxygen and high fecal coliform levels.[4]

Correspondingly, the limited quantities of water available from these headwater streams in the Atlanta metropolitan area pose water supply problems in meeting both consumptive use and instream quality needs. Utilities are considering transferring water from larger river systems in more sparsely populated areas of the state to meet the water demands at facility sites nearer the load center.

Scenario-induced changes. Chattahoochee (ASA 306) and Savannah-Altamaha River Basins (ASA 303). Although almost all of the projected increases in utility capacity and industrial fuel use occur in the Chattahoochee (ASA 306) and Savannah-Altamaha (ASA 303) river basins, no water availability problems or quality violations attributable to energy are shown at the ASA level. Both areas will experience increased water consumption and concentrations of total dissolved solids, sulfates, and potassium, caused almost entirely by electrical utilities.

The siting analysis shows most of the increased generation to be downstream in the Altamaha basin, and upstream, near Atlanta, in the Chattahoochee. Because the upstream flows will be less than those used by the national water quality model, local increases in TDS and sulfates in the

Chattahoochee may be greater than the 14 mg/liter and 2 mg/liter, respectively, predicted by the water quality analysis. Further reduction of flows to account for consumption by energy, urban, and other sources will also increase these concentrations. Auxiliary measures to maintain water supplies during critical flow conditions may be necessary to serve the projected demands near the Atlanta load center.

5.3.4 Air quality/visibility issues

Existing conditions. Several counties in Georgia have high SO_2 levels [20-40 micrograms (mg) per cubic meter (m^3)] but none have been cited by the EPA for nonattainment. Parts of the Chattanooga, Atlanta, and Savannah metropolitan areas do not meet the primary standard for TSP, and photochemical concentrations are high for the Atlanta region.

Scenario-induced changes. An additional county in the Atlanta area and one on the Georgia coast are expected to exceed PSD Class II increments for 1985. Still another county in the Atlanta area is expected to exceed these increments for both 1985 and 1990.

The Wolf Island Wilderness (Fig. 4.2) will experience a high impact from plume blight in 1990 from coal units in one of four adjacent counties. In both 1985 and 1990 the Cohutta Wilderness will experience a moderate impact from regional haze.

5.3.5 Land/ecological issues

No significant impacts on land or ecosystems are expected from the energy technologies in the scenario.

5.3.6 Health/safety issues

- Health hazards from exposure to fossil fuel combustion products are expected to present a moderate risk to the public.

Existing conditions. Georgia's principal energy industry is coal electric generation. Thus, the greatest energy-related occupational and public health hazards in this state are suffered by workers in steam plants (0.7 deaths and 24.1 injuries annually) and by the populations exposed to combustion products (220 to 3500 deaths annually, 60% confidence limits). Negligible oil electric generation and no nuclear electric generation existed in Georgia for 1975.

Scenario-induced changes. Occupational deaths and injuries from coal electric generation peak in 1985 and decline to values slightly in excess of 1975 figures by 1990. Occupational injuries from oil electric generation double between 1975 and 1985 (from 0.54 to 1.0 injuries annually), where they remain until 1990. Public health hazard from exposure to combustion products parallels this trend. Occupational and public health hazards from nuclear electric generation gradually increase from the zero values of 1975 to 0.55 accidental deaths, 0.91 to 3.6 accidental injuries, and 0.27 cancer deaths annually by 1990.

5.4 Kentucky

The projected increases in coal mining and combustion in Region IV will have the greatest impact on Kentucky, the nation's leading coal producer. Where other states in the region may suffer severe impacts in one or two categories, Kentucky will bear severe impacts in most categories. Current problems in the transportation of coal by truck will worsen. Five rural counties will experience significant socioeconomic impacts from the construction of new coal-fired power plants. Surface mining of coal will cause at least local water quality problems, and energy development may cause water supply problems in the Upper Ohio Basin. Air quality problems in much of the state will remain severe relative to the rest of the nation, and these problems will have severe effects on crops in the western and northern parts of the state. Mining accidents and diseases will claim more lives in Kentucky than in any other state in the region.

5.4.1 Institutional/political issues

- Current problems in the transportation of coal by truck will be aggravated because of increased coal production and inadequate roads and bridges.

Existing conditions. Kentucky is the nation's leading coal producer and most of its electricity is generated by coal-fired plants. In 1975 the state used 1.2×10^{15} Btu's of energy and about 13% of this energy was in the form of electricity delivered to end users. Coal accounts for over 50% of the energy used.

Kentucky enacted a power plant siting law in 1974 that permits the Department of Natural Resources and Environmental Protection, or any local pollution control district exercising concurrent jurisdiction with the department to issue siting certificates. The final authority over approval rests with the Public Service Commission.

Coal production in Kentucky has increased in spite of the federal strip mining laws which at times are more stringent than Kentucky regulations, or in conflict with them. Some state officials think that the new federal laws will require new mining technologies and the consolidation of small mining operations into larger ones, especially in the mountains in eastern Kentucky. Some jurisdictional questions are still to be resolved in federal/state water quality control efforts for the mining operations.

The transportation of coal by truck is seen as a major problem. In 1974, 80% of all eastern Kentucky coal was moved by a combination of truck and rail. Over 2,400 miles of coal haul roads and between 262 and 343 vehicle bridges are projected to be inadequate by 1980. The estimated cost of bridge replacement on the coal haul roads (1977 dollars) is $144,650,000 to $188,100,000; estimated cost of roadway reconstruction and rehabilitation is $950,415,000 to $1,220,695,000. A portion of the state coal severance tax goes toward road maintenance, but the state would like additional federal assistance as citizens feel the entire region benefits from the coal production and should share in the public costs. The state also anticipates some transportation problems on the Green River with additional barging being planned.

Labor management disputes are of concern to both public and private agencies because the disputes can significantly cut coal production and impact the economy of the state. The internal dissension in the United Mine Workers Union is a contributing factor in the problems.

Because of air quality problems in Louisville, officials foresee some difficulties for industries converting to coal or expanding their operations. Officials want to see improvement in technologies such as fluidized bed combustion which would allow high sulfur coal to be used without adverse environmental effects.

Scenario-induced changes. The Series C Scenario projects a continued coal economy for Kentucky with a tripled generating capacity (from 12,200 MWe in 1975 to 35,300 MWe in 1990), most of the increase coming from coal steam plants (Figs. 5.1 to 5.4 and Fig. 5.11). The total generating capacity projected by the scenario in 1990 is almost double that planned by the utilities. Both sources project increases in coal steam generation, and the scenario also predicts some increase in oil peaking capacity.

State officials do not see major problems in siting generating plants currently planned by utilities except for some air and water quality problems on the Green and Ohio Rivers. They feel there should be more state participation in the Environmental Impact Statement process.

If the scenario is realistic, it will aggravate present and anticipated problems in the state which have been described above because it is an extension of current activities.

5.4.2 Socioeconomic issues

- Significant socioeconomic impacts from the construction of energy facilities are projected for five Kentucky counties. This impact should be the result of an insufficient supply of available labor required to meet peak construction demand within commuting distance of the plant. These counties should experience a strain on public and private services and facilities from the influx of large numbers of construction workers.

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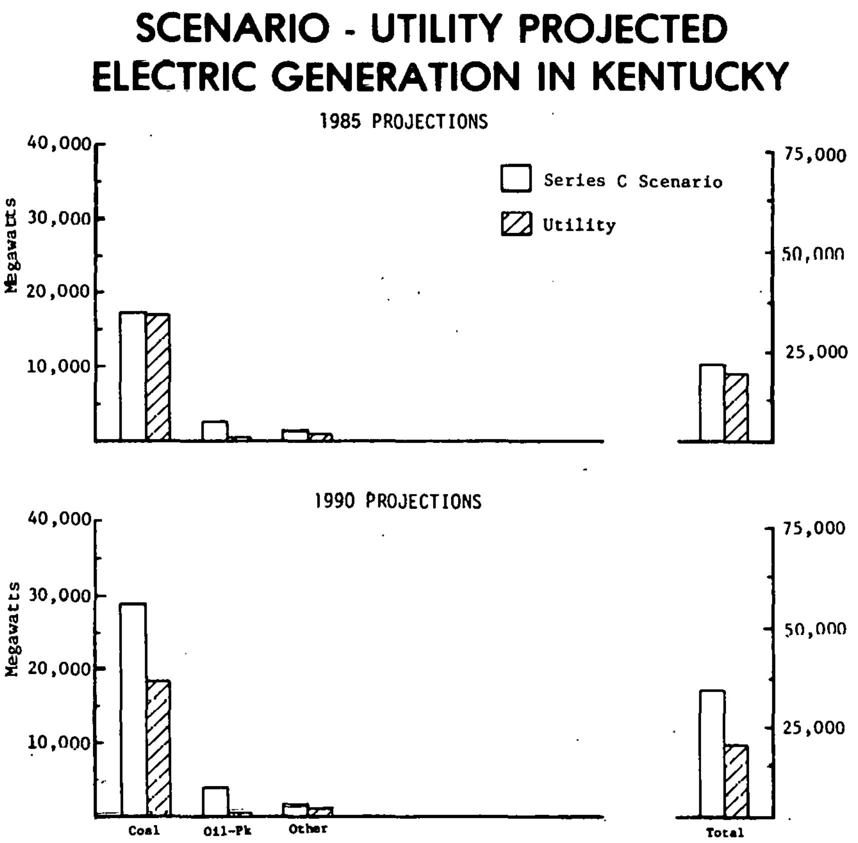

ENERGY SOURCE	GENERATING CAPACITY (MEGAWATTS)				
	1975	1985		1990	
	SERIES C	SERIES C	UTILITY*	SERIES C	UTILITY*
Coal	10,583	17,376	17,289	29,251	18,639
Oil Steam	655	342	113	605	113
Oil Peaking	113	2,600	243	4,102	243
Gas Peaking	110	110	110	92	110
Hydro	711	771	771	771	771
Comb. Cycle	0	401	0	401	0
TOTAL	12,172	22,080	18,526	35,222	19,876

*ORNL's Data from utility data file.

Fig. 5.11. Comparison of Mid-Range Projection Series C Scenario and utility construction plans in Kentucky.

- Kentucky is the nation's leading producer of coal. Coal mining is one of the state's major industries and the primary source of employment for many communities. The energy development projected for the state is entirely coal-related. Therefore the statewide impacts of this development are considered significant. This significance relates to the even greater role of coal mining in the state's economy rather than a low assimilative capacity for in-moving workers.

Background. Energy development is expected to occur in 18 Kentucky counties under the Series C Scenario. The majority of these counties are rural with low population densities and substantial amounts of substandard housing. Rural counties will have a lower assimilative capacity for impacts from substantial amounts of in-moving workers.

Scenario-induced changes. Of the 18 counties expected to receive energy development, five are expected to experience significant impacts (Fig. 5.12). These five counties are located in the Paducah, Louisville, and Cincinnati BEA regions. These five counties should experience at least one year of population growth greater than 10% from the construction of coal plants.

The other 13 counties are not expected to experience significant impacts as a result of minimal energy-related population increases. Many of these counties will receive coal mining development.

The five significantly impacted counties should experience, at construction peak, increases in the cost of public services and facilities of approximately \$1.3, \$1.3, \$0.444, \$0.660, and \$0.974 million.

One county, in the Evansville BEA region, is projected to experience project-related population growth of approximately 144 during the operating period. Increases in the annual cost of public facilities and services of approximately \$70,700 are also expected.

5.4.3 Water quality/availability issues

- Erosion control during and after surface mining will be difficult in the mountainous portions of the state. If the discharge levels specified for mining are attained, the national water quality model indicates some improvement in most of the state. However, unanticipated releases, as well as erosion and mine drainage from existing problem areas will probably continue to create at least local problems in all mining areas. In the Upper Ohio Basin (ASA 502) combined mining and utility effluents may violate criteria for total dissolved solids in 1985 and 1990 and phosphorus in 1985 only.

- The Ohio River Basin contains one of the major concentrations of economic activity in the nation, and it is the area most likely

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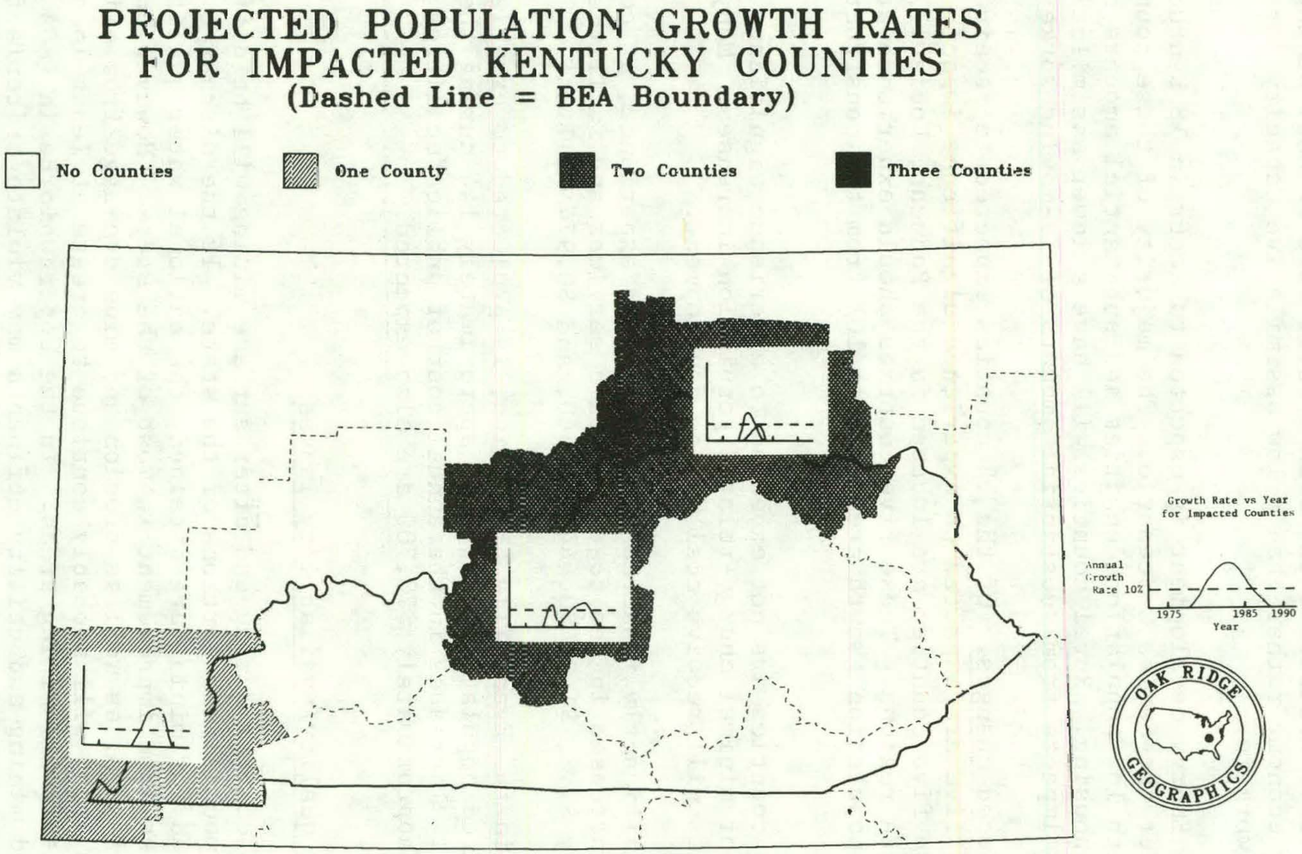

Fig. 5.12. Projected population growth rates for impacted counties in Kentucky.

to experience future energy growth because of its large coal reserves and proximity to major load centers. In Kentucky, potential water supply problems are evident at the ASA level in the Upper Ohio (ASA 502). The distortion inherent in ASA level analyses makes it likely that problems during low-flow periods will also occur downstream along the Ohio River. Local water shortages associated with energy production exist along the Green River and may hinder other similar mine-mouth developments in tributary areas.

Existing conditions. The state of Kentucky contains portions of five ASAs. The Upper Ohio Basin (ASA 502) including the Big Sandy River drains the northeastern corner of the state. Northwestern Kentucky is drained by the Ohio mainstem and its tributaries, the Licking, Kentucky, and Green Rivers (all included in ASA 505). Parts of southern Kentucky are drained by the Cumberland River (ASA 507) and smaller parts are in the Tennessee River (ASA 602) and Mississippi River (ASA 801) drainages.

Background levels of most water quality constituents vary among the different river basins. Water is hard (121-180 mg/liter calcium carbonate) in the Green, Salt, and parts of the Upper Ohio basins, moderately hard (60-120 mg/liter) in the rest of the state. The areas with harder water also have higher levels of dissolved sulfates and total dissolved solids, but the highest levels of suspended sediments (up to 200 mg/liter) are found in the Kentucky and Licking River basins, as well as in the upper end of the Ohio main stem drainage.[1,2]

Kentucky's major water quality problems are caused by coal mining, in both the eastern and western coal fields, and by municipal and industrial discharges. The areas most heavily affected by mining are the Big Sandy River and its tributaries in the Upper Ohio Basin (ASA 502), the Kentucky and Licking River basins, which are tributary to the lower Ohio River (combined within ASA 505), and the Cumberland River Basin (ASA 507).

The effects of mining observed in these areas include high levels of dissolved solids, sulfates, and trace chemicals including iron, manganese, and chlorides, and often low pH's.[4]

Water-for-energy quantity problems are exemplified on the Green River (within ASA 505) in western Kentucky, where electric generation must often be curtailed during the summer low-flow period due to insufficient streamflow. Similarly, during low-flow periods water quality conditions in the Big Sandy and other tributary basins are exacerbated by reduced streamflow.

Scenario-induced changes. Upper Ohio River Basin (ASA 502). Based on its large coal reserves and proximity to major load centers, energy development in the Upper Ohio Basin (ASA 502) is projected to increase substantially. Water consumption by energy, based on average monthly generation, grows from 45 million gallons per day in 1975, to 133 million gallons per day in 1985, and 197 million gallons per day in 1990. During conditions of maximum base load generation, these water-for-energy demands range up to 93 million gallons per day for the 1975 baseline, with 209 million gallons per day for 1985 and 292 million gallons per day for 1990 projected by the Scenario. The combined water demands by all sectors would consume about 30% of the estimated critical surface supply in 1990, with energy accounting for up to one-quarter of total water consumption — classifying the area as a potential water-for-energy quantity problem area. Such a reduction of flow by future consumptive use was not accounted for in the national water quality model, but would certainly result in raising the calculated pollutant concentrations.

The national water quality model indicates that meeting the standards of the federal surface mining laws could reduce the suspended sediment levels in this drainage by 150 mg/liter by 1985 and the iron levels by 8 mg/liter at the same time. However, mining levels are high throughout this period. Erosion control will be difficult in the mountainous terrain, and existing abandoned surface and deep mines will continue to degrade water quality unless reclaimed. Improvements will probably be evident in the large rivers and streams with problem areas remaining and recurring on some tributaries, particularly where there is increased consumptive use that reduces the quantity of streamflow available for pollutant dilution during low-flow periods.

In the upper Ohio (ASA 502) total dissolved solids from energy facilities are predicted to increase a total of 33% during the period of this analysis, from 451 mg/liter in 1975 to 560 mg/liter in 1985, to 603 mg/liter in 1990. About one-third of the increase is attributed to mining. The rest comes from increased generation of electricity using wet cooling towers.

Lower Ohio River Basin (ASA 505). Several tributaries, including the Kentucky, Licking, Green, and Salt Rivers are contained in ASA 505 as well as the Lower Ohio mainstem. The Kentucky, Licking, and Green Rivers all contain coal mining areas where improvements, primarily lower levels of suspended solids, iron, and manganese, should be evident. The Salt River Basin and the Ohio mainstem area have the highest population densities in the state, and the siting analysis indicates that most of the new generating capacity will be in these areas. There, the predicted increase in total dissolved solids by utilities would cause background levels of TDS to violate water supply standards in the Ohio mainstem by 1990.

At the aggregate level, no water-for-energy quantity problems were detected for the Lower Ohio (ASA 505); however, consideration of the amount of distortion inherent in ASA level analyses[9] indicates that the potential low-flow problems identified for the Upper Ohio Basin should continue along the middle lower Ohio until the confluence of the Cumberland River.

Existing water availability problems along the Green River (within ASA 505) and other tributaries remain, but are not exacerbated by conditions in the scenario because no new facilities were sited where previous problems existed.

Cumberland River Basin (ASA 507). No major water quality or availability impacts are expected in the Cumberland River Basin (ASA 507).

5.4.4 Air quality/visibility issues

Existing conditions. The air quality in Kentucky is among the worst in the Southeast. The EPA has cited seven counties in the Paducah, Louisville, Ashland, and Evansville (Indiana) areas for nonattainment of the primary SO_2 standard. Parts of these metropolitan areas and parts of the Cumberland Plateau in the southeastern part of the state do not meet the primary TSP standards. Surface mining of coal contributes much of the violation on the plateau.

Scenario-induced changes. Of the eight counties that currently do not meet TSP standards, four are expected to meet standards in 1985 and 1990. Most of these are on the Cumberland Plateau, and the improvement appears to result from the new federal surface mining law. One additional county, in the Cincinnati (Ohio) area, will not attain the TSP standard in 1985 and 1990. One county in the Paducah area will violate NAAQS in 1985.

The Mammoth Cave National Park (Fig. 4.2) will experience no significant impacts from plume blight through 1990, but it will be highly impacted by changes in regional haze between 1975 and 1985 or 1990. The haze will result from the additional coal-fired power plants that are expected in the region.

5.4.5 Land/ecological issues

- Surface mining is expected to clear 123,000 acres by 1985 and 175,000 acres by 1990. Much of this will occur in areas of steep slopes and high precipitation, which are adverse conditions for controlling erosion and acid drainage.

Existing conditions. The state of Kentucky lies solely within the eastern deciduous forest ecoregion.[5] It is dominated by the oak-hickory forest in the western half of the state, and the mixed mesophytic forest and Appalachian oak forest in the eastern half of the state. Grain farming — corn, soybeans, barley, and wheat — predominates in the western section of the state, and burley tobacco (a crop highly sensitive to SO_2) and alfalfa are the major crops in the central and northcentral regions.[10] Kentucky's production of more than 200,000 acres of tobacco is second in the South behind North Carolina. Approximately 2.2 million acres are contained in national parks and forests, wildlife refuges and natural areas, predominantly in the eastern section of the state in the Cumberland and Appalachian Mountains.

Scenario-induced changes. Kentucky appears to be the most heavily impacted state in the southern region. Strip mining is scheduled to clear an estimated 123,000 acres by 1985 and 175,000 by 1990. Deep mining will affect 5000 acres on the surface by 1990. The Indiana bat and Virginia big-eared bat, both listed as federally endangered species, are known to inhabit counties where surface mining of coal is now occurring or expected to occur.

Mining occurs in areas with steep slopes and high annual precipitation. These environmental conditions will make control of adverse conditions especially difficult. Much of the bituminous coal has a high sulfur content and the overburden is often pyritic in nature. The potential for both erosion and acid drainage is high and has been a continual problem in the region.

Three counties (Jackson, McCracken, and Muhlenberg) were all severely affected by 1975 SO_2 levels on soybeans, Irish potatoes, vegetables, corn, orchards, and berries. None of these three counties are expected to be impacted in 1985 and 1990.

Boone and Mason counties will be impacted by SO_2 in 1985 and 1990. Additionally in 1990, three other counties will be impacted (Oldham, Meade, and Trimble). These five counties have significant commodities of berries, wheat, tobacco, hay, orchards, and Irish and sweet potatoes. No known federally endangered or threatened species inhabit these counties.

5.4.6 Health/safety issues

- Employees of Kentucky's numerous energy industries will suffer the greatest occupational death and injury risk in the region. This is largely due to high production in the coal mining and coal electric generation industries.

- General public will receive the largest exposure to fossil fuel combustion products in the region.

Existing conditions. No other state in Region IV contains such a large number of impact categories. The combined total impact of deaths, injuries, and occupational diseases suffered by workers in this state greatly exceeds that for any other state in the region. The greatest number of occupational hazards exist in the coal mining industry, where annual accidental deaths are estimated to be 4.1 to 14 for surface mining and 13 to 47 annual deaths for deep mining. Annual injuries reflect the same trend, with 220 to 820 estimated annual injuries for surface mining and 1400 to 5300 injuries for deep mining. Figure 5.13 is a map of expected risk of accidental death from all coal mining for each county in 1975, 1985, and 1990. Although not included in the figure, occupational disease deaths for this industry are also significant.

Estimated risk to the general public from exposure to fossil fuel combustion products is considered greater than moderate. Occupational hazard in oil production and electric generation, natural gas production, and uranium enrichment is negligible.

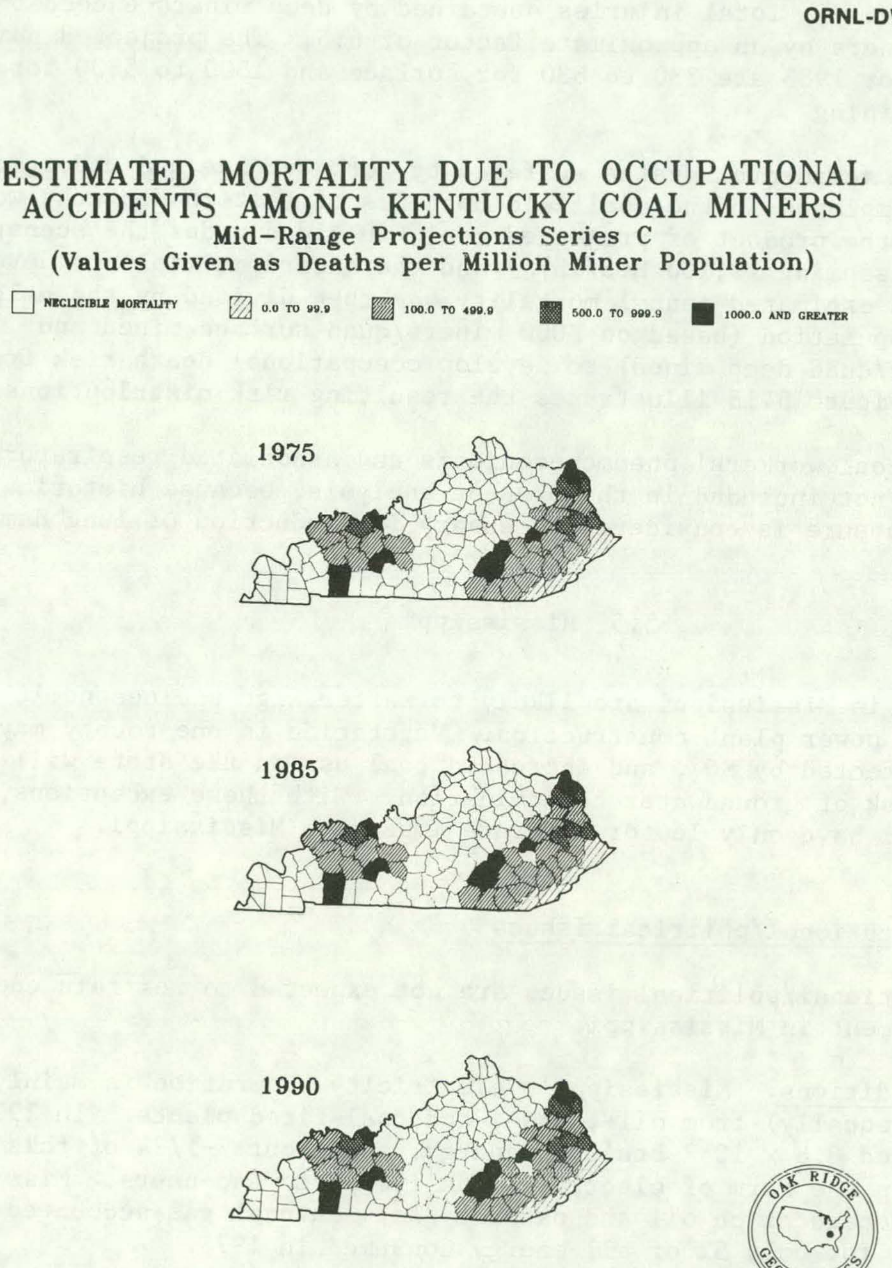

Fig. 5.13. Estimated mortality due to occupational accidents among coal miners in Kentucky.

Scenario-induced changes. The most serious hazards occur in the coal extraction industry. At the upper bound of the 60% confidence limits, underground mine accidents and occupational disease could claim as many as 51 and 38 lives annually in the peak production years of 1985 and 1990 respectively. Total injuries sustained by deep miners exceed those of surface miners by an approximate factor of 6.5. The projected numbers of injuries for 1985 are 230 to 830 for surface and 1500 to 5800 for underground mining.

The number of accidental deaths suffered by both surface and underground coal miners employed in the coalfield counties of eastern Kentucky was estimated as the product of projected coal Btu mined under the scenario conditions (assuming 13,100 Btu/lb)[11] and the hazard multipliers developed at BNL. This estimated annual mortality was then divided by the calculated miner population (based on 3000 miners/quad surface mined and 14,200 miners/quad deep mined) to develop occupational death risk from accidents. Figure 5.13 illustrates the resulting risk distributions.

Deaths from coal workers' pneumonoconiosis and associated respiratory disease were not included in the present analysis, because historical workplace exposure is considered necessary for induction of lung damage.

5.5 Mississippi

Two counties in Mississippi are likely to suffer high socioeconomic impacts from power plant construction. Vegetation in one county may be adversely affected by SO_2, and increased coal use in the state will raise the risk of groundwater contamination. With these exceptions, the scenario will have only low or moderate impact on Mississippi.

5.5.1 Institutional/political issues

- Institutional/political issues are not expected to restrain energy development in Mississippi.

Existing conditions. Mississippi's electricity generation is mainly (and almost equally) from oil-, gas-, and coal-fired plants. In 1975 the state used 0.8×10^{15} Btu's of energy, and about 7-1/2% of this energy was in the form of electricity delivered to end-users. Mississippi is heavily dependent on oil and natural gas. Natural gas accounted for 32% and coal for only 5% of all energy consumed in 1975.

Mississippi does not have a power plant siting law; however, the Public Service Commission has authority to grant a "Certificate of Public Convenience and Necessity."

State officials think the coal conversion sections of the NEA will cause economic problems for utilities and industries. The industrial sector requires up-to-date knowledge of the best technologies for industries converting to coal and the subsequent costs of such conversion. In general, Mississippi will be sympathetic to the industries' problems and is concerned that economic growth might be stunted because of the regulations.

A state official sees a general lack of coordination for energy programs as a problem. This includes lack of communication and planning between utilities and different state agencies, and between DOE and the state officials. The state officials say they have little or no input into major DOE programs, and do not always know ahead of time what programs DOE will be implementing in the state.

Scenario-induced changes. The total generating capacity predicted by the Series C Scenario for Mississippi will more than triple, from 4,600 MWe in 1975 to an estimated 16,500 MWe in 1990 (Figs. 5.1 to 5.4 and 5.14). In 1990 more total generating capacity is predicted by the scenario than by the utilities. The scenario predicts about three times the coal and thirty times the oil peaking capacity than do the utilities. The utilities predict about twice the nuclear capacity in 1990 as that assumed by the scenario.

Concern has been expressed about the impact of the increased need to transport coal into the state on the rail lines. The scenario projection of a larger amount of coal-fired electric generating capacity may further aggravate the problem. State officials are also concerned in general about the environmental effects of increased use of coal.

Officials say that disposal of nuclear wastes will be a problem in siting nuclear plants. There are proposals in the state legislature concerning nuclear disposal and storage and some are restrictive. Although federal regulations distinguish hazardous nuclear wastes from other hazardous wastes, the Mississippi law being drafted combines the two. This may present a conflict in application between the two sets when both are on the books. The Mississippi regulation is anticipated to be more stringent than the federal laws.

5.5.2 Socioeconomic issues

- Significant socioeconomic impacts from the construction of energy facilities are expected for two counties in Mississippi. These impacts should be the result of an insufficient supply of available labor required to meet peak construction demand within commuting distance of the plant. These counties should experience a strain on public and private services and facilities from the influx of large numbers of construction workers.

Background. Under the scenario, energy development is expected to occur in seven Mississippi counties. The majority of these counties are rural with low population densities and substantial amounts of substandard housing. Rural counties will have a lower assimilative capacity for impacts from substantial amounts of in-moving workers.

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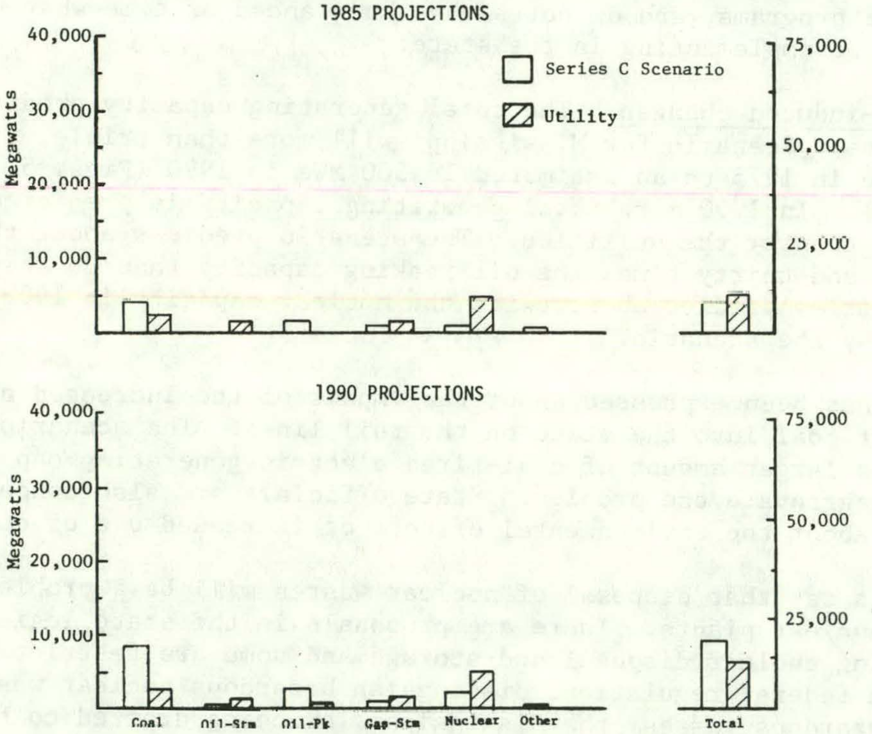
SCENARIO - UTILITY PROJECTED ELECTRIC GENERATION IN MISSISSIPPI



ENERGY SOURCE	GENERATING CAPACITY (MEGAWATTS) 1975 SERIES C	1985 SERIES C	1985 UTILITY*	1990 SERIES C	1990 UTILITY*
Coal	1,604	4,240	2,287	8,852	2,987
Oil Steam	1,046	48	1,372	225	1,372
Oil Peaking	99	1,876	99	2,913	99
Gas Steam	1,800	1,175	1,977	1,175	1,977
Gas Peaking	50	50	50	50	50
Nuclear	0	1,250	5,033	2,500	5,033
Other	0	750	0	750	0
TOTAL	4,599	9,389	10,818	16,465	11,318

*ORNL's Data from utility data file.

Fig. 5.14. Comparison of Mid-Range Projection Series C Scenario and utility construction plans in Mississippi.

Scenario-induced changes. Of the seven counties with predicted energy development, only two are expected to experience significant impacts. Construction of a nuclear plant in the Jackson BEA region and a coal plant in the New Orleans BEA region should result in at least one year of population growth greater than 10% for these counties (Fig. 5.15).

For the above counties, respectively, the projected noncoincident peak work force requirements are 2,200 and 2,087. These counties are also projected to experience total inmigration, including dependents of 2,715 and 2,649 during the peak construction year.

The other five counties are not projected to experience significant impacts as a result of minimal energy-related population increases.

The two significantly impacted counties should experience, at construction peak, large increases in the costs of public services and facilities of approximately $1.2 million each. The other five counties should experience smaller increases in these costs.

None of the counties are projected to encounter impacts during the operating phase of these developments.

5.5.3 Water quality/availability issues

- No major water quality changes are expected as a result of direct energy effluents. However, the scenario shows electric utilities beginning to use large amounts of coal between 1975 and 1990. Because the entire state is underlain by unconsolidated aquifers, controlling groundwater contamination from coal handling and ash disposal facilities may become a problem.

- No significant water-for-energy problems can be detected in supporting the level of energy development projected for Mississippi.

Existing conditions. The western half of Mississippi is drained by the lower Mississippi mainstem (ASAs 801, 802, and 803). The northeastern portion is part of the Tombigbee River Basin (ASA 308), and the southeastern portion contains the Pascagoula and Pearl River Basins (ASA 309).

The waters of Mississippi are soft (<60 mg/liter hardness as calcium carbonate) and low in dissolved solids (<120 mg/liter) except along the Mississippi main stem where levels are slightly higher (120-350 mg/liter). Suspended solids levels are more variable. The highest concentrations are found in the Yazoo River basin in the northwestern part of the state where levels range from 200 to 500 mg/liter. Lowest levels (<50 mg/liter) occur in the Pascagoula Basin, and the rest of the state has intermediate concentrations[1,2] (50 to 200 mg/liter).

Urban pollution is not a major problem in Mississippi except along the eastern Gulf Coast. Agricultural runoff, including pesticides, has

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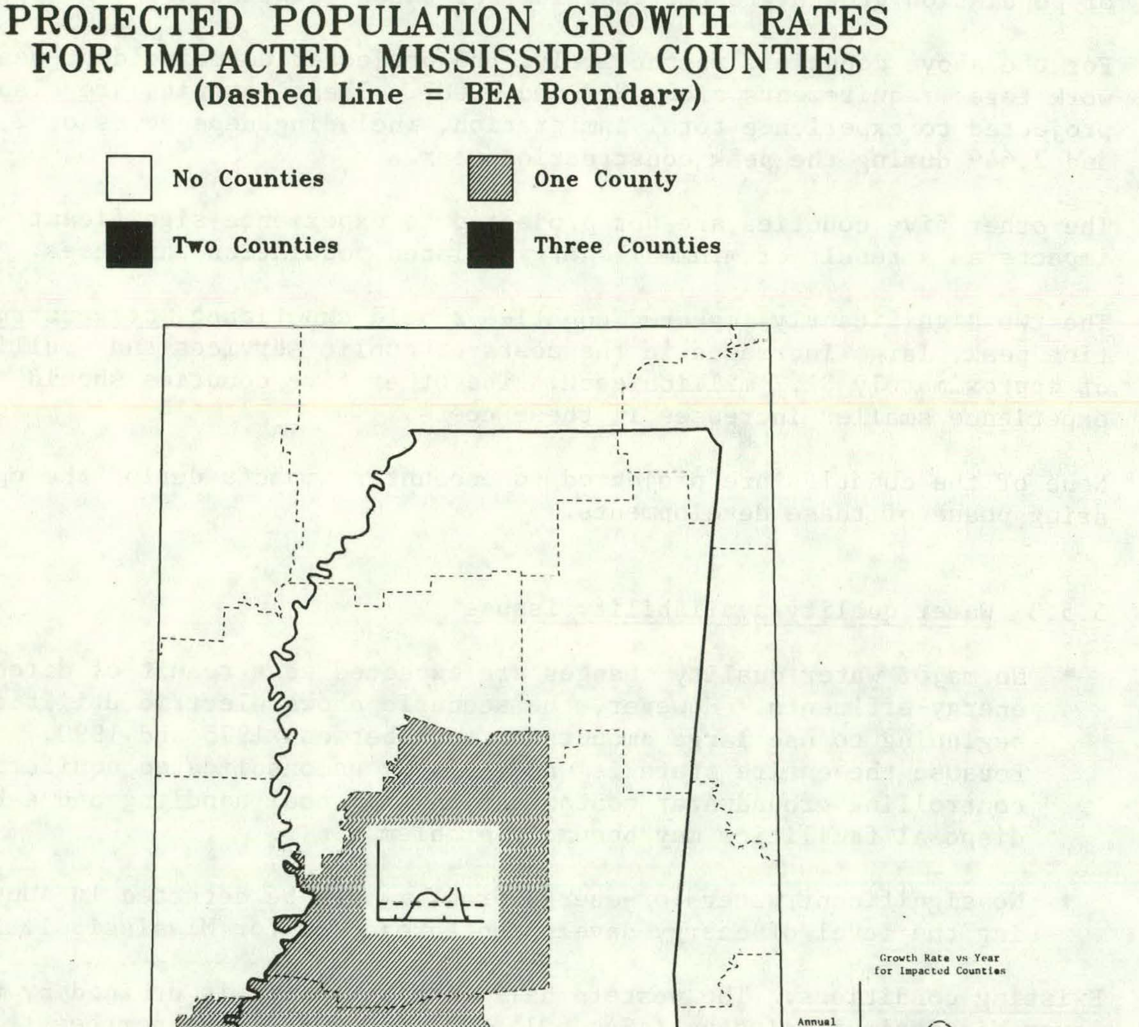

Fig. 5.15. Projected population growth rates for impacted counties in Mississippi.

affected streams in the northwestern part of the state, and industrial pollution is a local problem in other areas. Naturally high temperatures and low pH keep some undisturbed streams in southern Mississippi from meeting EPA water quality criteria.[4]

Scenario-induced changes. Yazoo-Mississippi Basin (ASA 802). New electric utility generation may increase TDS levels in the Yazoo-Mississippi area 25% by 1985 and 40% by 1990. The resulting concentrations will be <200 mg/liter, below the water quality criterion for TDS, but high enough to indicate possible local violations if generating capacity is concentrated near urban areas.

Mississippi Delta (ASA 803). Although water availability is not a problem along the Mississippi River, concern exists that water consumption upstream may reduce the flow at the mouth sufficiently to change the extent of tidal saltwater intrusion.

5.5.4 Air quality/visibility issues

Existing conditions. Although five counties in Mississippi have annual average TSP concentrations of more than 50 micrograms per cubic meter, only one of these (in the Hattiesburg AQCR) has been cited for non-attainment of the primary TSP standard. Two counties in the state have average annual SO_2 concentrations of 20 to 35 micrograms per cubic meter.

Scenario-induced changes. One county near Memphis, Tennessee is expected to exceed the PSD Class II increment for 1990.

The state has no Class I areas.

5.5.5 Land/ecological issues

- No significant impacts are forecasted.

Existing conditions. Mississippi is similar to its neighboring state of Louisiana in that it is subdivided into the southeastern mixed forest; the southern flood plain forest; and the beech, sweetgum, magnolia, oak, and pine forest ecoregions. Over 50 percent of the state is in forest, with the greatest majority of that being commercial forest. Approximately 25 percent of the state is employed as cropland, with almost 3.7 million acres in soybeans and over a million acres in cotton.

Scenario-induced changes. Only one county (Jones) will be impacted by SO_2, although the levels decline significantly from 1975 to 1985 and then start to rise by 1990. Besides having crops of grain, hay, orchards, and berries, commercial forest accounts for 260,000 acres of the county.

5.5.6 Health/safety issues

- The general public will sustain a moderate risk from exposure to fossil fuel combustion products.

Existing conditions. Oil refinery and natural gas production workers are estimated to sustain 20-51 annual injuries in 1975. Mortality for each industry was estimated to equal <1 per year. Health effects from oil and nuclear electric generation are considered negligible.

Scenario-induced changes. Occupational hazards from coal electric generation in Mississippi are among the lowest in the region (0.2 to 0.7 deaths and 5.3 to 24.3 injuries). Although the electric power output from oil-fired plants is comparable to that from coal-fired plants, the hazard is five times less. In addition, oil electric generation in Mississippi is approximately one order of magnitude less than that generated by Florida. Health effects of fossil fuel combustion in Mississippi and Florida are the lowest of any in the Southeast. (See previous discussions on Florida for comparable technology effects figures.)

5.6 North Carolina

Eastern North Carolina may experience low flow supply problems under the conditions of the scenario, and local water shortages are possible elsewhere in the state. One county is expected to experience significant socioeconomic impacts. Air quality will be a problem in the western part of the state, and it may affect vegetation there.

5.6.1 Institutional/political issues

- Institutional/political issues are not expected to restrain energy development in North Carolina.

Existing conditions. North Carolina electricity generation is mainly from coal-fired plants with some assist from hydro and nuclear. In 1975 the state used 1.4×10^{15} Btu's of energy, and about one-eighth of this energy was in the form of electricity delivered to end users.

Industries use natural gas as an irreplaceable feedstock for textile, fertilizer, and ammonia production, and they will be greatly affected by its supply and price. Natural gas de-regulation will help the state's industries because they are willing to trade an increase in cost for an assured supply. With the increased availablity of natural gas, state officials do not foresee industries converting to coal in the near future. The allocation of natural gas has been a major problem, and the state filed "No. 76-2102, State of North Carolina and North Carolina Utilities Commission, Petitioners versus Federal Energy Regulatory Commission, Respondent" with the United States Court of Appeals for the

District of Columbia Circuit. The court opinion pointed out that there are defects in the implementation of the current curtailment procedures. First, the implementation plan allocates gas on the basis of out-of-date base period data. Secondly, some customers are totally dependent on one pipeline supplier and others are supplied by several pipelines, some of which have fewer curtailments. The Court of Appeals ruled that the Federal Energy Regulatory Commission curtailment procedures were inequitable and must be revised.

Officials see room for improvement in federal-state relations. Three main areas were cited: lack of flexibility in the state use of federal energy and environmental funds; lack of local relevance in federal energy guidelines; and inadequate attention to the problems of implementation and enforcement (including cost) of the federal energy programs by the states.

Scenario-induced changes. The Series C Scenario requires a doubling of generating capacity from 14,800 MWe in 1975 to 29,700 MWe in 1990 (Fig. 5.16). The major increases will be in coal, nuclear, and oil peaking capacity (Figs. 5.1 to 5.4). The total generating capacity required by the scenario is somewhat greater than the utilities projections. The scenario requires more coal and oil peaking generation than the utilities project; and the utilities project almost twice the nuclear capacity in 1990 as that required by the scenario.

North Carolina does not have a power plant siting law. However, several state agencies must certify elements of plant construction under direction of the State Utilities Commission at an informal one-stop proceeding. The state officials do not see much difficulty in siting these new generating plants, but environmental control agencies foresee some environmental impact associated with the increased use of coal. No concerns were expressed as to the adequacy of rail and road systems to transport the coal.

There has been support from the governor's office for nuclear installations. A bill limiting the transport of nuclear materials was defeated in the legislature, but the impact of the accident at Three Mile Island on future nuclear plant development in the state is unknown.

The scenario calls for combined cycle facilities, and state legislation has been introduced for cogenerating facilities.

5.6.2 Socioeconomic issues

- Significant socioeconomic impacts from the construction of energy facilities are projected for one North Carolina county. This county should experience a strain on public and private services and facilities from the influx of large numbers of construction workers.

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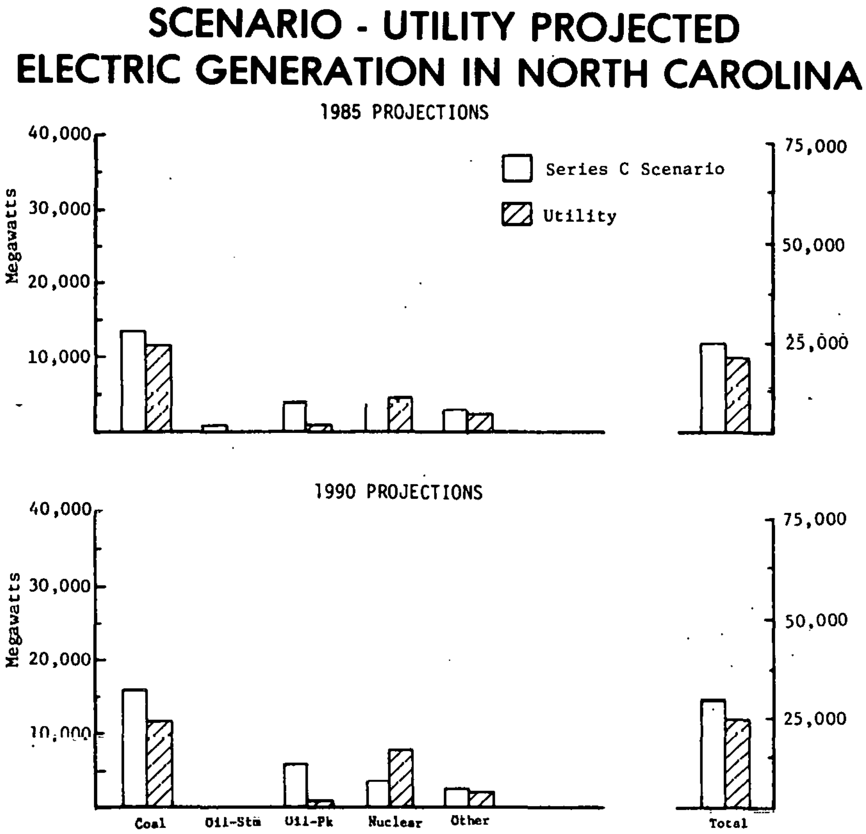

ENERGY SOURCE	GENERATING CAPACITY (MEGAWATTS)				
	1975	1985		1990	
	SERIES C	SERIES C	UTILITY*	SERIES C	UTILITY*
Coal	10,333	14,003	12,905	16,626	12,905
Oil Steam	588	623	0	0	0
Oil Peaking	755	4,153	735	6,137	735
Nuclear	790	3,971	4,871	3,971	8,851
Hydro	2,232	2,238	2,304	2,238	2,304
Comb. Cycle	135	765	0	765	0
TOTAL	14,833	25,753	20,815	29,737	24,795

*ORNL's Data from utility data file.

Fig. 5.16. Comparison of Mid-Range Projection Series C Scenario and utility construction plans in North Carolina.

Background. Under the scenario, energy development is expected to occur in four North Carolina counties. Two of these counties are rural with low population densities and substantial amounts of substandard housing, while the others are urban. Rural counties will have a lower assimilative capacity for impacts from substantial amounts of in-moving workers.

Scenario-induced changes. Of the four counties expected to receive energy development, only one county, located in the Wilmington BEA region, is expected to experience significant impacts (Fig. 5.17). This county should experience at least one year of population growth greater than 10% from the construction of a coal plant.

The one significantly impacted county is projected to have a peak work force requirement of 2,280 and a total of 3,024 in-migrants, including dependents.

The other three counties are not projected to receive large energy-related population increases.

All four counties should experience, at construction peak, large increases in the cost of public services and facilities of approximately $1.6, $2.7, $0.527, and $0.930 million.

None of the four counties should receive impacts during the operating phase of the developments.

5.6.3 Water quality/availability issues

- Water-for-energy development is projected to generate low-flow supply problems in eastern North Carolina (ASA 301 Roanoke-Cape Fear) by 1990. Possible local water shortages resulting from periodic droughts may also occur in meeting demands in inland headwater areas near the load centers of Charlotte, Greenville, and Winston-Salem. None of the rivers along the Carolina Piedmont is capable of supporting numerous large facilities; even in combination, they cannot serve all of the demands near the load centers.

- No major water quality issues or constraints are anticipated at the ASA level.

Existing conditions. The eastern North Carolina coastal plain drains to the Atlantic through the Roanoke, Tar, Neuse, and Cape Fear Rivers (ASA 301). The center of the state, the Piedmont region, drains southward through the Pee Dee and Santee Rivers (ASA 302). Mountainous western North Carolina drains westward to the Tennessee River system (ASA 601). The waters of the state are soft (<60 mg/liter calcium carbonate) and low in both dissolved solids and suspended sediments.[2]

The water quality issues are different in each of the three major drainage regions of the state. The greatest water quality problems occur in the Piedmont region (ASA 302), where population and industry

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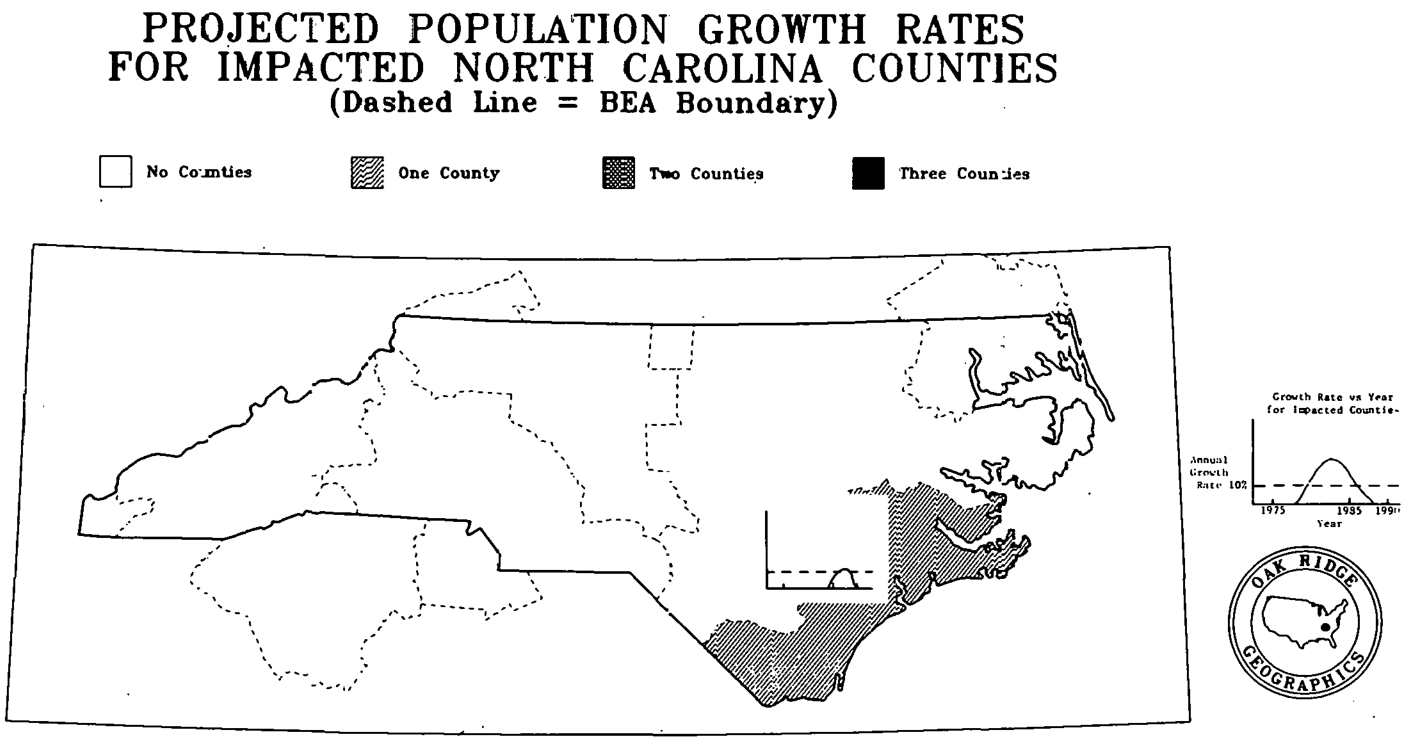


Fig. 5.17. Projected population growth rates for impacted counties in North Carolina.

are densest. The warmer, slower rivers of the coastal plain (ASA 301) have less ability to assimilate wastes, though the loadings are lower.

Scenario-induced changes. Roanoke-Tar-Neuse-Cape Fear River Basins (ASA 301). The national water quality analysis indicates that the levels of dissolved solids attributable to energy facilities in ASA 301 might be increased by as much as 117% by 1990. Though this represents a 60% increase from the total background levels in 1975, no violations of water quality criteria are anticipated at the ASA level.

This conclusion may be misleading, however, considering that the ASA discharge is actually distributed among several rivers, and that most of the new generating facility sites are in upstream reaches nearer the energy demand centers of Charlotte, Greenville, and Winston-Salem.

Furthermore, high water-for-energy demands combined with water use by other sectors is calculated to reduce the critical surface supply estimated to be available for the entire ASA by between 19 and 27 percent. This reduction would increase the likelihood of higher concentrations of pollutants than was calculated by the national water quality model in the more densely populated area of the Carolina Piedmont.

Pee Dee-Edisto River Basins (ASA 302). See discussion under South Carolina.

Upper Tennessee River Basin (ASA 601). The siting analysis shows little change in levels of energy activities in the North Carolina portions of the Upper Tennessee Basin (ASA 601).

5.6.4 Air quality/visibility issues

Existing conditions. All of North Carolina meets primary standards for SO_2, although four counties have annual average concentrations in the range of 40 to 60 micrograms per cubic meter. Background levels of TSP are generally below 30 micrograms per cubic meter, but 21 counties have annual average concentrations ranging between 50 and 95 micrograms per cubic meter. Two counties in the extreme western portion of the state and two in the Piedmont Basin were in nonattainment for TSP in 1975.

Scenario-induced changes. Nonattainment will continue in 1985 in all but one of the western counties, with one of the Piedmont counties attaining the standard in 1990. One county in the extreme west will exceed the PSD Class I increment in 1985 and 1990.

A high impact from plume blight on the Linville Gorge Wilderness (Fig. 4.2) is projected from coal units in one of seven adjacent counties through 1990. Coal units in another adjacent county are projected to produce low impacts through 1990. The Great Smoky Mountains National Park, the Joyce Kilmer-Slickrock Wilderness, and the Swanquarter Wilderness will each experience moderate or high impacts from projected changes in regional haze since 1975. By 1990 only Shining Rock's haze level impacts will become low, while Swanquarter's will change from high to moderate.

5.6.5 Land/ecological issues

Existing conditions. The eastern 80 percent of the state lies within the southeastern mixed forest ecoregion, and the westernmost mountainous section of the state lies within the Appalachian oak forest.[5] It is in this westernmost section that the impacts are predicted to occur. This ecoregion is dominated primarily by white and northern red oak with northern hardwoods (maple, beech, birch and hemlock) and spruce and fir in the higher elevations. Most of this region is national forestland with a significant portion along the Tennessee border included in the Great Smoky Mountains National Park. Relatively little commercial farming is done in this section compared to the rest of the state. A large proportion of the acreage is in commercial forests.

Scenario-induced changes. Buncombe and Haywood counties in the westernmost part of the state will be impacted by SO_2, with levels of the pollutant rising through 1990. Perhaps the most serious impact will occur on the commercial forests, which account for over 390,000 acres. Additionally, crops such as Irish potatoes, sweet potatoes, hay, and berries will also be affected. This appears to be the only significant impact occurring in the state as forecast by the Series C Scenario.

5.6.6 Health/safety issues

- North Carolina and Kentucky share the distinction of possessing the greatest total occupational hazard from coal electric generation in the Southeast.

Existing conditions. Occupational and public health effects from oil electric generation, nuclear fuel fabrication, and nuclear electric generation are estimated to be negligible. Coal electric generation is estimated to result in 34 occupational injuries and 1.0 occupational death per year. However, exposure of the general public to combustion products of this industry is estimated to produce between 200 and 3200 excess deaths per year (60% confidence limits).

Scenario-induced changes. In the Southeast, North Carolina shares with Kentucky the greatest total occupational hazard from coal electric generation. As a direct result of the coal-fired plants emission in these two states, between 1975-1990 1.0 to 1.6 deaths and 34 to 54 injuries are projected to occur in each state. In contrast, occupational hazard and health effects from oil electric generation and fossil fuel combustion are moderate for the region. Occupational hazard from nuclear fuel fabrication in North Carolina is estimated to equal 15.9% of the U.S. total (0.54 annual occupational deaths).

5.7 South Carolina

Apart from high socioeconomic impacts in one county, and the possibility that uncertainty over nuclear power may delay construction of the new nuclear plants projected by the scenario, the energy development projected for South Carolina should cause little difficulty in the state.

5.7.1 Institutional/political issues

- Institutional/political issues are not expected to restrain energy development in South Carolina.

Existing conditions. Coal and nuclear plants accounted for 60% of the electric generating capacity in South Carolina in 1975, with the rest coming mainly from hydro and oil. In that year the state used 0.8×10^{15} Btu of energy, and 12.5% was in the form of electricity delivered to end users.

Industries in South Carolina are dependent on natural gas as a fuel and as a feedstock for major textile industries. The supply and price of gas will have an impact on the state economy. The increase in gas supply has eased problems in the state, and South Carolina has a new propane piping and storage system. There are no serious problems at present with industries converting to coal. When conversion becomes necessary, it is hoped that advanced technologies such as fluidized bed combustion will be available. For industries using gas as a feedstock, de-regulation will mean an increase in materials cost.

South Carolina enacted a power plant siting law in 1973 granting the Public Service Commission authority to coordinate state agency review and issue approval. South Carolina works with the states of North Carolina and Virginia (when appropriate) in determining need for power and making plans for siting plants. The state permitting agencies work with utilities in solving problems as they arise.

South Carolina is projected to be heavily dependent on nuclear power by 1990. State and utility officials are concerned about the length of time needed for licensing nuclear plants, and about the problems of nuclear waste disposal. Some state officials would like to see the licensing procedure reformed, in part, through the elimination of redundant hearings, and they foresee a continuing problem in that legislation is drafted at the national level and then applied broadly to all situations. They would prefer that the process include more response to local situations.

Although additional hydro power is not predicted in the scenario, or in listed utility plans, interest in more hydro power has been expressed. One site was previously blocked by environmentalists, but it may be considered again.

Scenario-induced changes. The Series C Scenario requires South Carolina to be very dependent on nuclear power by 1990 (Figs. 5.1 to 5.4 and Fig. 5.18). Of its estimated doubling of electric generating capacity (10,300 MWe in 1975 to 22,900 MWe in 1990), 7,100 MWe is to come from nuclear. The scenario and utility projections match closely, with the scenario requiring a little more total capacity and more capacity from oil peaking and coal plants than the utilities project.

The length of time necessary for licensing nuclear plants may be a problem in meeting scenario and utility projections. The ultimate impact of the nuclear accident at the Three Mile Island electric plant is unknown, but shortly after the accident the governor of South Carolina indicated support for continuing the nuclear construction in the state. Some officials say that if the nuclear option is lost, a major investment must be made in railroads to transport the coal which will be needed for other generating plants, but good sites are available for coal-fired facilities.

5.7.2 Socioeconomic issues

- Significant socioeconomic impacts from the construction of energy facilities are projected for one South Carolina county. This county should experience a strain on public and private services and facilities from the influx of large numbers of construction workers.

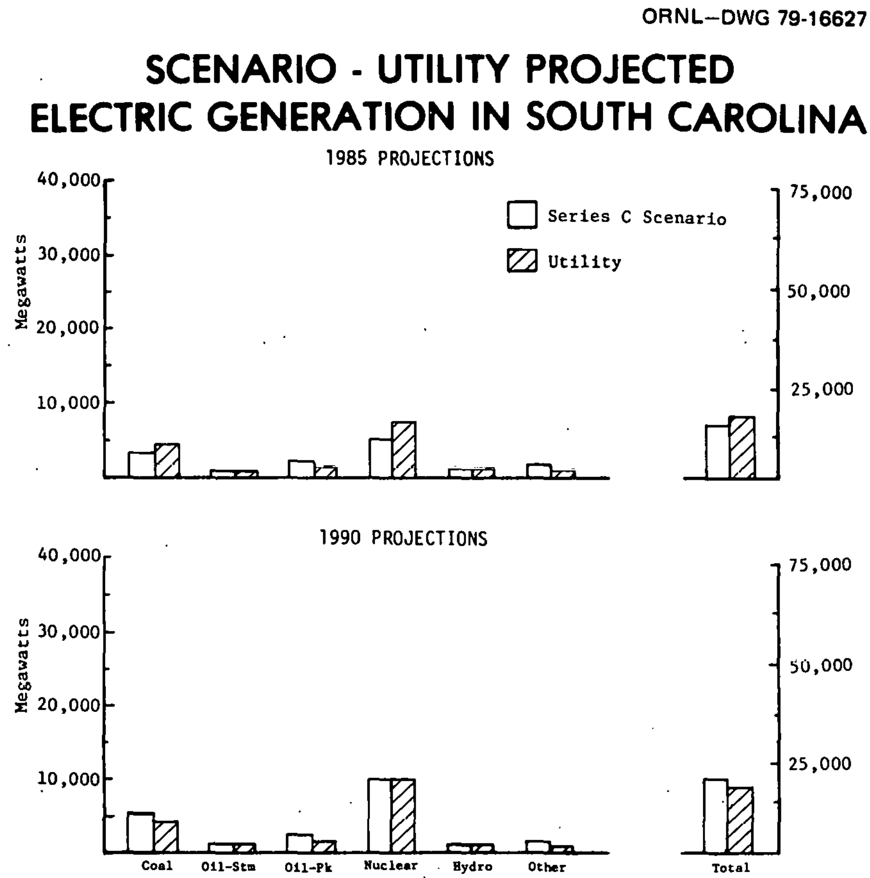
Background. Energy development is expected to occur in six South Carolina counties under the Series C Scenario. These counties are, in general, rural with similar socioeconomic characteristics. Rural counties will have a lower assimilative capacity for impacts from substantial amounts of in-moving workers.

Scenario-induced changes. Of the six counties expected to receive energy development, only one county in the Greenville BEA region is expected to experience significant impacts (Fig. 5.19). This county should experience at least one year of population growth greater than 10% from the construction of a nuclear plant.

The one significantly impacted county has a projected peak work force requirement of 4,973 and a projected total of 7,803 in-migrants, including dependents. The other five counties are not projected to receive large energy-related population increases.

The one significantly impacted county should experience, at construction peak, an increase of $4.1 million in the cost of providing public services and facilities. Many of the other counties also should have increases in these costs, some of which are large.

One county in the Charleston BEA region is projected to experience project-related population growth of approximately 68 during the operating period. Increases of approximately $44,450 in the annual cost of public facilities and services are also expected.



ENERGY SOURCE	GENERATING CAPACITY (MEGAWATTS)				
	1975	1985		1990	
	SERIES C	SERIES C	UTILITY*	SERIES C	UTILITY*
Coal	3,222	3,502	4,212	5,502	4,212
Oil Steam	1,053	959	903	959	903
Oil Peaking	1,188	2,144	1,772	2,537	1,772
Nuclear	3,278	5,331	7,764	10,376	10,324
Hydro	1,027	1,027	1,027	1,027	1,027
Comb. Cycle	0	750	196	750	196
Pump. Stor	610	1,090	1,090	1,728	1,090
TOTAL	10,378	14,803	16,964	22,879	19,524

*ORNL's Data from utility data file.

Fig. 5.18. Comparison of Mid-Range Projection Series C Scenario and utility construction plans in South Carolina.

ORNL-DWG 79-12642

PROJECTED POPULATION GROWTH RATES
FOR IMPACTED SOUTH CAROLINA COUNTIES
(Dashed Line = BEA Boundary)

No Counties
One County
Two Counties
Three Counties

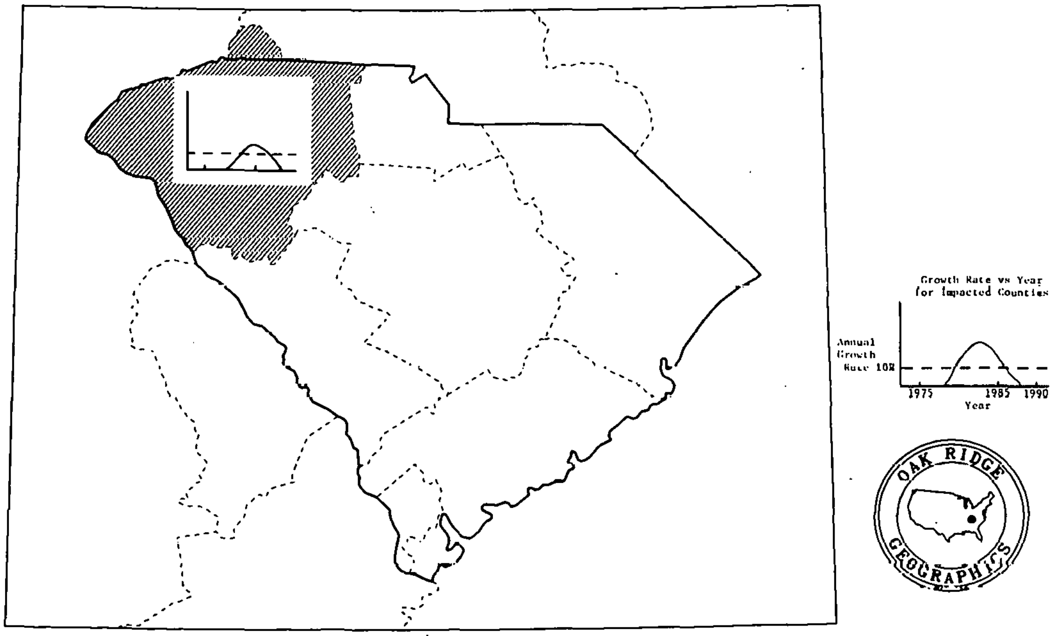


Fig. 5.19. Projected population growth rates for impacted counties in South Carolina.

5.7.3 Water quality/availability issues

- No major water quality issues or constraints are anticipated at the ASA level.
- Although no water shortages resulting from energy development can be identified at the ASA level, this does not preclude water availability as a major concern for energy facility siting in South Carolina. Potential problem areas exist both within the Pee Dee-Edisto Basin (ASA 302), which is projected to experience the nation's greatest increase in water consumption for energy, and within the Savannah River Basin (ASA 303).

Existing conditions. Though almost the entire state of South Carolina lies within ASA 302, that one aggregated subarea is drained by three separate rivers, the Pee Dee, the Santee, and the Edisto. The Savannah River, in a separate ASA (303), drains the western edge of the state.

South Carolina's rivers are naturally soft (<60 mg/liter $CaCO_3$), and low in dissolved and suspended solids.[2] Water quality in the state is generally good. Non-point source pollution has been identified as a problem near urban areas in the Santee-Cooper, Edisto, Pee Dee and Savannah basins. Coastal areas suitable for shellfish are recognized as valuable and ecologically sensitive and are given special protection.[4]

Scenario-induced changes. Pee Dee, Santee, and Edisto Rivers (ASA 302). In terms of water quality, background concentrations of total dissolved solids, sulfates, and potassium may increase by approximately 125% each, mainly from concentration by cooling towers at electrical generating facilities. However, no widespread water quality criteria violations are detected at the ASA level.

The Pee Dee-Edisto Basin (ASA 302) is projected to contain the nation's greatest increase in water consumption by energy. This consumption would exceed 282 million gallons per day for maximum base load generation in 1990, giving ASA 302 the third largest water-for-energy total (behind ASA's 704 and 502). Despite this consumption, no water level availability problem is apparent.

However, the area's flow is actually divided among three distinct drainage basins, and the distribution of energy facilities is primarily in the upper upstream reaches of these streams. Thus, there is a potential for energy-related water problems to occur within the state, although they are not evident at the ASA level.

5.7.4 Air quality/visibility issues

Existing conditions. Background concentrations of TSP average less than 25 micrograms per cubic meter. Fourteen counties have annual average TSP concentrations in the range of 50 to 95 micrograms per cubic meter and two of these, in the Charleston area, have been cited for nonattainment. Annual average SO_2 concentrations do not exceed 17 micrograms per cubic meter, and the entire state meets the SO_2 standards.

Scenario-induced changes. Nonattainment for TSP is forecast to continue along the coast in 1985. The PSD Class I increment will be exceeded in one county in 1990. This county is also in the Charleston area.

Two of five counties adjacent to the Cape Romain Wilderness (Fig. 4.2) are projected to produce low plume blight impacts through 1990 from oil-steam, oil peaking, and coal units. There are no significant regional haze impacts projected.

5.7.5 Land/ecological issues

Existing conditions. South Carolina predominantly lies within the southeastern mixed forest ecoregion with the westernmost tip of the state in the Appalachian oak ecoregion and the eastern section of the border with Georgia in the southern floodplain forest ecoregion.[5] Within the southeastern forest ecoregion, where the anticipated impacts from air pollution are forecast to occur, there exist five major vegetation types.[12] These are, in decreasing order of abundance, oak, hickory, pine forest, southern floodplain forest, Pocosin (a pine-holly association), southern mixed forest and live oak-sea oats. The southern floodplain forest and live oak-sea oats association has been classified as resistant, the southern mixed forest as sensitive and the remainder as intermediate to SO_2 pollution.

The counties immediately adjacent to those located along the Atlantic Coast are the top grain producing counties (corn, soybeans, wheat, and barley) in the state.[13]

Scenario-induced changes. Georgetown and Dorchester counties will be impacted by SO_2 under the Series C Scenario in 1985 and 1990. The only major crop is sweet potatoes; however, 278,000 acres of commercial forest are also present. In contrast to this scenario, the NCUA scenario indicated a potential SO_2 impact on the heart of South Carolina's grain producing region and also a greater potential impact on softwood forests in other areas of the state.[7]

5.7.6 Health/safety issues

- The general public will sustain a moderate risk from exposure to fossil fuel combustion products.

Existing conditions. Coal electric generation is estimated to result in 10 occupational injuries and 0.3 occupational deaths in 1975. Exposure to combustion products of this and the small oil electric generation industry is estimated to produce between 100 and 1600 excess deaths (60%

confidence limits). Health effects of uranium hexafluoride (UF_6) conversion, nuclear fuel fabrication and reprocessing, nuclear waste management and nuclear electric generation are considered negligible.

Scenario-induced changes. South Carolina has the largest nuclear support industry in the region. Occupational deaths and injuries from each nuclear industry are <1 until the peak year (1990), when 1.1 radiation-induced cancer deaths are expected to occur annually from exposure during fuel fabrication. Occupational hazard and health effects from fossil fuel combustion are moderate for the region through time. Oil electric generation and the resulting health effects are an order of magnitude less than those of Florida. (0.01 projected deaths and 0.7 projected injuries for 1975 to 1985. No production in 1990.)

5.8 Tennessee

Tennessee's coal transportation system may be strained by increased coal production, and four rural counties in the state are likely to experience significant socioeconomic impacts from new nuclear power plant construction. Coal mining may affect water quality in some localized areas. Exposure to combustion products of fossil fuels may cause 230 to 4800 deaths per year.

5.8.1 Institutional/political issues

- Coal haul roads, bridges, and railroads in the mountainous sections of East Tennessee will require upgrading.

- Institutional/political issues are not expected to restrain energy development in Tennessee except in terms of the public's reservations concerning nuclear power.

Existing conditions. Electricity generation in Tennessee was mainly from coal-fired plants with an assist from hydro in 1975. In that year, the state used 1.5×10^{15} Btu of energy, and about 14% of it was in the form of electricity delivered to end-users. Coal accounted for 43% of the total energy consumed in 1975.

The presence of two very large federal agencies in the state (the Department of Energy which is represented primarily by the Oak Ridge installations, and the Tennessee Valley Authority which provides the electric power for the state) complicates energy planning by the state agencies. Unlike most states in the southern region, Tennessee has neither a plant siting review process by the Public Service Commission nor a power plant siting law. Although the sites and fuel cycles chosen are TVA rather than state decisions, the state has generally concurred. The administration decision to stop construction of the breeder reactor has met with vigorous opposition in Tennessee.

The combination of the Clean Air Act and Coal Conversion Sections of the National Energy Act may slow economic growth in Tennessee. Consequently the state is considering providing general data (especially air quality information) indicating acceptable areas of growth for new industries to aid industrial growth.

Scenario-induced changes. The scenario requires that electric generating capacity in Tennessee will increase from approximately 12,200 MWe in 1975 to approximately 33,500 MWe in 1990 (Figs. 5.1 to 5.4). The scenario and utility projections almost coincide, with the major difference being that there is no oil peaking capacity in the utility projections (Fig. 5.20). Two-thirds of the increase (approximately 13,200 MWe) is predicted to be in new nuclear capacity. The impact on these plans of the nuclear accident at the Three Mile Island plant is unknown.

Tennessee's production of coal is increasing, and it is required to increase under the Series C Scenario. Coal haul roads, bridges, and railroads in the mountainous sections of East Tennessee will require upgrading to be adequate to the demands placed on them. An estimated 292 to 517 miles of coal haul road will be inadequate by 1980, with an estimated cost (in 1977 dollars) of $80,415,000 to $179,210,000 to reconstruct and rehabilitate them. An estimated 27 to 60 bridges on these roads will also be inadequate and the estimate to replace them (in 1977 dollars) is $14,000,000 to $33,000,000.

5.8.2 Socioeconomic issues

- Significant socioeconomic impacts from the construction of energy facilities are expected for four counties in Tennessee. These counties should experience a strain on public and private services and facilities from the influx of large numbers of construction workers.

Background. Energy development is expected to occur in eight Tennessee counties. These counties are all rural and therefore have a low assimilative capacity for impacts from substantial amounts of in-moving workers.

Scenario-induced changes. Significiant impacts from nuclear plant construction are expected in one county in each of the Bristol, Chattanooga, and Nashville BEA regions. Another county in the Nashville region is expected to receive significant impacts from coal mining development (Fig. 5.21).

For the above four counties, respectively, the projected noncoincident peak work force requirements are approximately 4800, 3800, 5500, and 900. These counties are also projected to experience the following numbers of total in-migrants, including dependents of approximately 6300, 5400, 9600, and 600 during the peak construction year.

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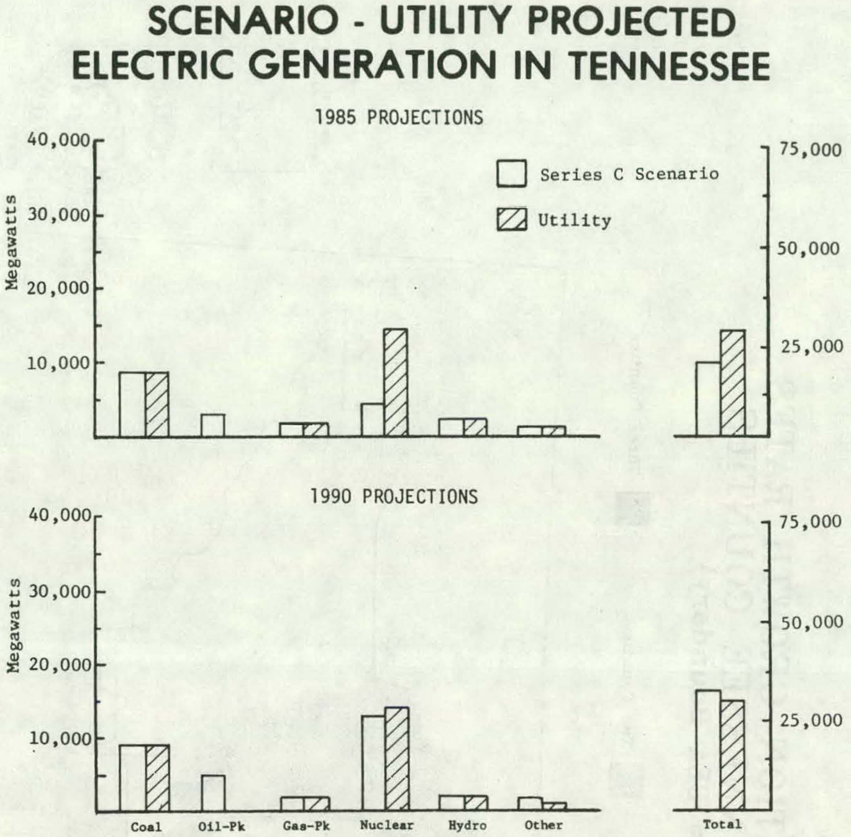

ENERGY SOURCE	GENERATING CAPACITY (MEGAWATTS)				
	1975	1985		1990	
	SERIES C	SERIES C	UTILITY*	SERIES C	UTILITY*
Coal	9,241	9,241	9,241	9,241	9,241
Oil Peaking	0	3,216	0	5,094	0
Gas Peaking	1,808	1,808	1,808	1,808	1,808
Nuclear	0	4,650	14,515	13,215	14,515
Hydro	2,194	2,194	2,194	2,194	2,194
Pump. Stor.	0	1,300	1,300	1,950	1,300
TOTAL	13,243	22,409	29,058	33,502	29,058

*ORNL's Data from utility data file.

Fig. 5.20. Comparison of Mid-Range Projection Series C Scenario and utility construction plans in Tennessee.

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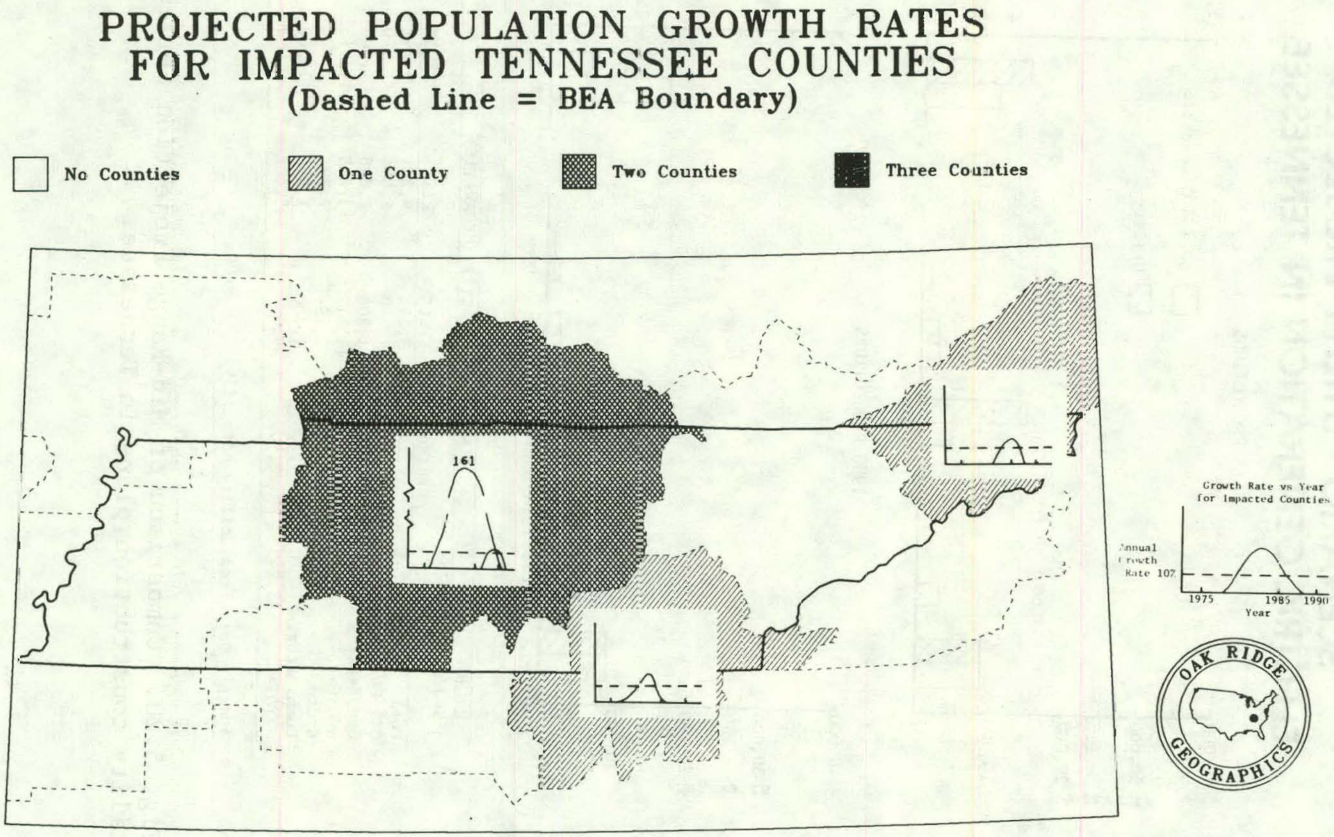

Fig. 5.21. Projected population growth rates for impacted counties in Tennessee.

The other four counties are not expected to experience significant impacts as a result of minimal energy-related population increases. These counties will be the site of coal mining development.

The three counties receiving nuclear plants should experience, at construction peak, large increases in the cost of public services and facilities of approximately $2.8, $2.4, and $4.3 million. The other significantly impacted county should experience a smaller increase in costs, $.265 million.

The significantly impacted county receiving coal mine development is projected to experience project-related population growth of approximately 600 during the operating period. Increases in the annual cost of public facilities and services of approximately $.257 million are also expected.

5.8.3 Water quality/availability issues

- If discharge standards are met, no water quality constraints are expected. However, surface mining is expected to increase in the Appalachian coal fields where erosion control is difficult and continuing problems will occur, with at least local impacts.

- No major water supply problems are foreseen for energy development even during critical supply periods within Tennessee, primarily because of TVA's ability to regulate streamflow. Severe drought periods in the past, however, have caused TVA to reduce generation at individual power plants.

Existing conditions. North-central Tennessee is drained by the Cumberland River (ASA 507) and the extreme western part of the state is drained by the Mississippi (ASA 801). The rest of the state is in the drainage of the Tennessee River (ASAs 601 and 602).

Waters of the Cumberland basin and parts of the central and upper Tennessee Valley are moderately hard and have levels of dissolved solids (120 to 350 mg/liter) somewhat higher than the rest of the state. The other basins in the state have soft water. Suspended sediment levels are low (<50 mg/liter) except in extreme west Tennessee, where they range from 100 to 200 mg/liter.[2]

Water quality in the state is generally very good. Local pollution problems exist near some major urban areas. Surface mines in the Cumberland River basin and in the Clinch River basin have also caused water quality problems. The steep terrain and heavy rainfall of the mining areas make erosion control extremely difficult.[4]

Scenario-induced changes. Cumberland River Basin (ASA 507). If the erosion control standards of the federal surface mining regulations are met, the national model indicates that suspended solids from mining could be reduced 99% by 1985. Total dissolved solids (TDS) from mining will also decrease slightly, although the predicted TDS increase from new generating capacity will overwhelm that small decrease. The national model shows that background TDS levels may be doubled, from 100 to 220 mg/liter, by 1990. Electrical utilities account for 112 mg/liter of the increase, their discharges growing 40% from 1975 to 1985, and 172% between 1975 and 1990. The expected concentration will not violate the domestic water supply criterion (250 mg/liter) but it is close enough to that criterion to indicate possible local problems.

Upper Tennessee River Basin (ASA 601). Few changes are anticipated in the upper Tennessee basin (ASA 601). Total suspended solids from mining are expected to decrease 99% by 1990, but they represented only 10% of the suspended solids measured in 1975. Dissolved solids from energy facilities, mainly electrical utilities, will increase 135% between 1975 and 1990, but the total increase is less than 17 mg/liter and should be insignificant.

Lower Tennessee River Basin (ASA 602). As in the Upper Tennessee basin, in the Lower Tennessee basin, changes in concentrations of pollutants will be slight. Suspended sediment, caused primarily by mining, will decrease by 99% by 1990; and dissolved solids, mainly from electric utilities, will increase 122% at the same time. Actual concentrations involved are low, however, and the changes are only 4 mg/liter TSS and 20 mg/liter (TDS).

5.8.4 Air quality/visibility issues

Existing conditions. Three counties have annual average SO_2 concentrations in the range of 35 to 50 micrograms per cubic meter, with one in the Nashville (Humphreys) AQCR being cited by the EPA for nonattainment. Background concentrations for TSP generally average less than 30 micrograms per cubic meter, but fourteen counties have annual TSP average concentrations in the range of 50 to 105 micrograms per cubic meter. Six counties, in the Memphis, Nashville, Knoxville, Chattanooga, and Bristol areas, do not meet the primary standard for TSP.

Scenario-induced changes. In all but one of the counties in the Knoxville AQCR, TSP violations are expected to continue in 1985. The PSD Class II increment will be exceeded for one county (Stewart) in the Nashville AQCR in 1985 and 1990.

One of ten counties adjacent to the Great Smoky Mountains National Park (Fig. 4.2) is projected to produce impacts from low plume blight through 1990 from oil peaking units. Changes in regional haze in the Great Smoky Mountains and in the Joyce Kilmer-Slickrock Wilderness are expected to cause impacts through 1990.

5.8.5 Land/ecological issues

Existing conditions. The state of Tennessee is primarily dissected into four ecoregions: the Appalachian oak forest and the mixed mesophytic in the eastern third of the state; the oak-hickory in the central and western portions; and the southern floodplain forest in the extreme west.[5] The southeastern mixed forest also makes a slight incursion into the south-central section of the state.

The financially most important crops in the state are soybeans and cotton (western section), tobacco (northcentral and northeastern sections), and corn (throughout the state). The total income from these crops in 1975 was approximately $210, $65, $140, and $100 million dollars, respectively.[14]

Scenario-induced changes. Surface mining of coal in northeast Tennessee will increase to a total of 21,000 acres from 1975 to 1990. The regions impacted by surface mining lie within the mixed mesophytic forest and Appalachian oak forest with steep topography and abundant rainfall (50 to 60 inches/yr). As a result, many of the impacts associated with coal mining in east Kentucky can be anticipated to occur in Tennessee. Three known endangered fish species occur within the counties where surface mining activity will take place — the slender chub, the yellow-fin madtom, and the Plateau musky. These species may suffer serious consequences if the water quality is impaired.

Knox County, a producer of tobacco, hay, sweet potatoes, vegetables, melons and corn will be impacted by SO_2 levels in 1985 and 1990. Roane County, producing only hay crops, will be impacted in 1975 and 1985. Only Shelby County is impacted from 1975 to 1990, with berries being the major crop. Sumner County is affected from 1975 to 1990, with major crops of grain, hay and berries.

Knox (Knoxville), Shelby (Memphis), and Sumner (Nashville) counties all are centers of, or adjacent to, rapidly expanding metropolitan areas. As a result, there probably exists a greater potential impact on the natural and agricultural ecosystems from urban sprawl than from air pollution. However, again as indicated in Ref. 7, the agricultural crops in the entire western section of the state may receive serious impacts from air pollution due to expanding coal-fired generating plants.

5.8.6 Health/safety issues

- Tennessee's general public shares top ranking with Kentucky in magnitude of exposure to fossil fuel combustion products. It is estimated that the public will sustain a greater-than-moderate health risk from this exposure.

Existing conditions. Coal mining and coal electric generation are estimated to present the greatest energy-related workplace hazards in the state. Approximately 1 to 4 deaths and 98 to 360 injuries are expected to occur annually from coal mining accidents (Fig. 5.22 has a map of estimated risk by county for 1975). Between 0.5 and 1.7 deaths and 28 to 33 accidents should occur annually in coal-fired steam plants. The concentration of combustion facilities in the area should produce a greater-than-moderate health risk to the public from exposure to combustion products. Health hazard from the remaining energy-related facilities are estimated to be negligible.

Scenario-induced changes. Tennessee is second only to Kentucky in its number and diversity of impact categories and in hazards from coal electric generation (0.8 to 0.9 deaths and 25 to 30 injuries annually) and fossil fuel combustion (230 to 4800 deaths annually). Figure 5.22 shows the estimated risk from all coal mining by county for 1985 and 1990. Tennessee is third in the region, following Alabama, for all coal extraction hazards. Because oil production is so low, no deaths and only one injury per year per 10^6 Btu are estimated to occur through 1990. By contrast, the Tennessee public shares top place with Kentucky in suffering the region's largest number of health effects from fossil fuel combustion (a greater-than-moderate value). The total of occupational hazard from uranium enrichment and nuclear fuel fabrication is expected to result in less than 1 death annually between 1979 and 1990.

ORNL-DWG 79-12653

ESTIMATED MORTALITY DUE TO OCCUPATIONAL ACCIDENTS AMONG TENNESSEE COAL MINERS

Mid-Range Projections Series C
(Values Given as Deaths per Million Miner Population)

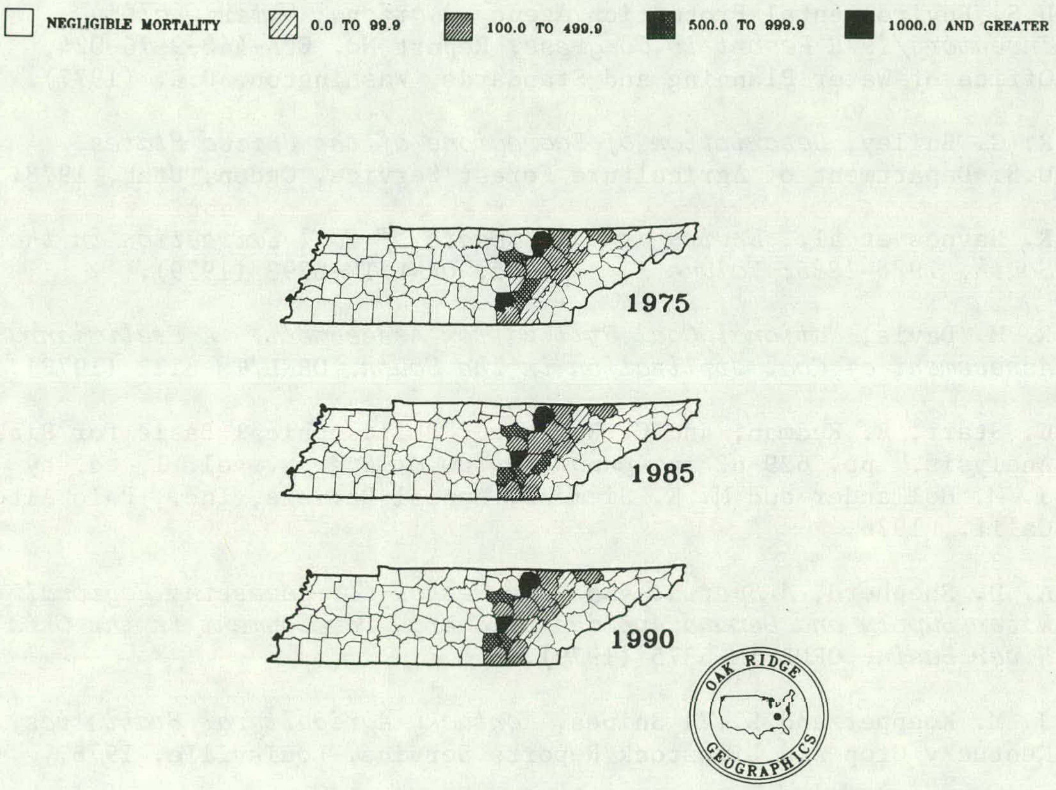

Fig. 5.22. Estimated mortality due to occupational accidents among coal miners in Tennessee.

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APPENDIX A

STATE MATRICES

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Table A.1. Environmental impacts of the Mid-Range Projection Series C Scenario at the regional or state level in Alabama[a]

Energy source	Air quality	Water		Land		Health and safety[b]	Socioeconomics			
		Quality	Availability[c]	Ecology/ land use	Solid waste		Local socio- logic factors	Local economics	Regional economics	Legislative/ institutional
Utilities										
Coal	H	L	L	M	L	H	L	L	L	M
Oil	L					L	L	L	L	L
Gas	L					L	L	L	L	L
Nuclear							M	M	M	H
Conservation										
Efficiency improvements							L	L	L	L
Urban wastes							L	L	L	L
Cogeneration							L	L	L	L
Solar							L	L	L	L
General										
Utility	H	L					M	M	M	M
Industry	L	L			L		M	L	L	M
Mining		M		M			M	M	M	M

[a]Criteria for ranking impacts found in Table 1.2.

[b]Includes occupational and other health effects not covered by air quality.

[c]Includes groundwater.

Table A.2. Environmental impacts of the Mid-Range Projection Series C Scenario at the regional or state level in Florida[a]

Energy source	Air quality	Water		Land		Health and safety[b]	Socioeconomics			
		Quality	Availability[c]	Ecology/ land use	Solid waste		Local socio- logic factors	Local economics	Regional economics	Legislative/ institutional
Utilities										
Coal	M	H	H	M		L	L	L	L	M
Oil	L					M	L	L	L	M
Gas	L					M	L	L	L	L
Nuclear						L	M	M	M	H
Conservation										
Efficiency improvements							L	L	L	L
Urban wastes							L	L	L	L
Cogeneration							L	L	L	L
Solar							L	L	L	L
General										
Utility	M	M					H	M	M	M
Industry	L	M					M	L	L	M
Mining		L		L			M	L	L	M

[a] Criteria for ranking impacts found in Table 1.2.

[b] Includes occupational and other health effects not covered by air quality.

[c] Includes groundwater.

Table A.3. Environmental impacts of the Mid-Range Projection Series C Scenario at the regional or state level in Georgia[a]

Energy source	Air quality	Water		Land		Health and safety[b]	Socioeconomics			
		Quality	Availability[c]	Ecology/ land use	Solid waste		Local socio-logic factors	Local economics	Regional economics	Legislative/ institutional
Utilities										
Coal	M	L	L	L		M	L	L	L	L
Oil	M					M	L	L	L	L
Gas	L					M	L	L	L	L
Nuclear	L					L	M	M	M	M
Conservation										
Efficiency improvements							L	L	L	L
Urban wastes							L	L	L	L
Cogeneration							L	L	L	L
Solar							L	L	L	L
General										
Utility	M	L					M	L	L	M
Industry	L	L					L	L	L	L
Mining		L		L			L	L	L	L

[a]Criteria for ranking impacts found in Table 1.2.

[b]Includes occupational and other health effects not covered by air quality.

[c]Includes groundwater.

Table A.4. Environmental impacts of the Mid-Range Projection Series C Scenario at the regional or state level in Kentucky[a]

Energy source	Air quality	Water		Land		Health and safety[b]	Socioeconomics			
		Quality	Availability[c]	Ecology/ land use	Solid waste		Local socio-logic factors	Local economics	Regional economics	Legislative/ institutional
Coal										
Electric	H	M	M	H		H	L	H	H	M
Oil	L					L	L	L	L	L
Gas	L					L	L	L	L	L
Nuclear	L					L	L	L	L	L
Conservation										
Energy efficiency improvements							L	L	L	L
Urban waste							L	L	L	L
Cogeneration							L	L	L	L
Solar							L	L	L	L
General										
Utility	H	M					L	M	M	M
Industry	L	L					L	L	L	M
Mining		M		H			L	M	M	M

[a]Criteria for ranking impacts found in Table 1.2.

[b]Includes occupational and other health effects not covered by air quality.

[c]Includes groundwater.

Table A.5. Environmental impacts of the Mid-Range Projection Series C Scenario at the regional or state level in Mississippi[a]

Energy source	Air quality	Water		Land		Health and safety[b]	Socioeconomics			
		Quality	Availability[c]	Ecology/ land use	Solid waste		Local socio- logic factors	Local economics	Regional economics	Legislative/ institutional
Coal										
Electric	L	L	L	L		L	L	M	M	M
Oil	L					M	L	L	L	L
Gas	L					M	L	L	L	L
Nuclear						L	M	M	M	M
Conservation										
Energy efficiency improvements							L	L	L	L
Urban waste							L	L	L	L
Cogeneration							L	L	L	L
Solar							L	L	L	L
General										
Utility	L	L	L		L		M	M	M	M
Industry	L	L			L		L	L	L	L
Mining		L		L			L	L	L	L

[a]Criteria for ranking impacts found in Table 1.2.

[b]Includes occupational and other health effects not covered by air quality.

[c]Includes groundwater.

Table A.6. Environmental impacts of the Mid-Range Projection Series C Scenario at the regional or state level in North Carolina[a]

Energy source	Air quality	Water: Quality	Water: Availability[c]	Land: Ecology/ land use	Land: Solid waste	Health and safety[b]	Socioeconomics: Local socio-logic factors	Socioeconomics: Local economics	Socioeconomics: Regional economics	Socioeconomics: Legislative/ institutional
Coal										
Electric	M	M	M	M	L	H	L	L	L	M
Oil	L					M	L	L	L	L
Gas	L					L	L	L	L	M
Nuclear						L	M	M	M	M
Conservation										
Energy efficiency improvements							L	L	L	L
Urban waste							L	L	L	L
Cogeneration							L	L	L	L
Solar							L	L	L	L
General										
Utility	M	L			L		M	M	M	M
Industry	L	L			L		L	L	L	L
Mining		L		L			L	L	L	M

[a] Criteria for ranking impacts found in Table 1.2.

[b] Includes occupational and other health effects not covered by air quality.

[c] Includes groundwater.

Table A.7. Environmental impacts of the Mid-Range Projection Series C Scenario at the regional or state level in South Carolina[a]

Energy source	Air quality	Water		Land		Health and safety[b]	Socioeconomics			
		Quality	Availability[c]	Ecology/ land use	Solid waste		Local socio- logic factors	Local economics	Regional economics	Legislative/ institutional
Coal										
Electric	L	L	L	M		L	L	L	L	L
Oil	L					M	L	L	L	L
Gas	L					L	L	L	L	M
Nuclear						L	M	M	M	M
Conservation										
Energy efficiency improvements							L	L	L	L
Urban waste							L	L	L	L
Cogeneration							L	L	L	L
Solar							L	L	L	L
General										
Utility	L	L					M	M	M	M
Industry	L	L					L	L	L	L
Mining		L		L			L	L	L	L

[a]Criteria for ranking impacts found in Table 1.2.

[b]Includes occupational and other health effects not covered by air quality.

[c]Includes groundwater.

Table A.8. Environmental impacts of the Mid-Range Projection Series C Scenario at the regional or state level in Tennessee[a]

Energy source	Air quality	Water		Land		Health and safety[b]	Socioeconomics			
		Quality	Availability[c]	Ecology/ land use	Solid waste		Local socio-logic factors	Local economics	Regional economics	Legislative/ institutional
Coal										
Electric	H	L	L	H		H	L	L	L	L
Oil						L	L	L	L	L
Gas						L	L	L	L	L
Nuclear						L	M	M	M	M
Conservation										
Energy efficiency improvements							L	L	L	L
Urban waste							L	L	L	L
Cogeneration							L	L	L	L
Solar							L	L	L	L
General										
Utility	H	L					M	M	M	M
Industry	L	L					L	L	L	L
Mining		L		M			L	L	L	M

[a]Criteria for ranking impacts found in Table 1.2.

[b]Includes occupational and other health effects not covered by air quality.

[c]Includes groundwater.

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