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1975 Energy Conditions in the South

Patricia L. Rice

**ORNL
REGIONAL
STUDIES
PROGRAM**

OAK RIDGE NATIONAL LABORATORY
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Economic Analysis Section
Energy Division

1975 ENERGY CONDITIONS IN THE SOUTH

Patricia L. Rice

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ABSTRACT

This report depicts energy supply and demand conditions in the South in 1975 and highlights differences in production and utilization patterns relative to the United States (some of the consumption data is for 1974). Significant changes during the previous three years are noted to provide continuity with the predecessor report, Energy Conditions in the South: 1972. The most important changes are the substantial increase in nuclear generation of electricity, the absolute and relative decline in oil and gas production, and the increase in per capita energy consumption relative to the nation.

Each state within the region is described in detail to ascertain important sub-regional differences in energy conditions. The intent is to provide a description rather than analysis of regional energy patterns, noting variations and emphasizing the comparative advantages of the South. Such a presentation can yield insight into the future role of the region in contributing to the economic growth and welfare of the nation as its natural resource base is depleted and the transition to alternative energy sources is made.

I. OVERVIEW: THE SOUTH

The South is currently the most important region of the nation in terms of its energy production and energy-related resources. In this report the South is defined to include the East South Central and West South Central census regions, as well as Florida, Georgia, North Carolina, South Carolina, Virginia, and West Virginia in the South Atlantic region. This region produced over 68% of the total energy in the nation in 1975, but contained only 29% of the nation's population. The region's relative advantage is in the production of hydrocarbons. It has 85% of the natural gas liquids production, 83% of the natural gas production, and 71% of the crude oil production.

In terms of total BTU value the region has an even greater abundance of energy in its coal reserves, particularly the rich coal of the West South Central region. In 1975 the region produced approximately half the nation's coal. With only 17% of the remaining reserves, however, its share of the future production of coal is projected to decline. Table I indicates both the production and remaining reserves of fossil fuels as well as hydro and nuclear capacity (conversion rates are shown in Section IV).

Table I. Energy production and reserves in the South

Energy Input (national share)	Production		Proved reserves	
	1972 (Btu x 10 ¹²)	1975	1972 (Btu x 10 ¹⁵)	1975
Crude oil	14,616 (73%)	12,555 (71%)	111.7 (49%)	92.0 (49%)
Natural gas	20,776 (84%)	18,227 (83%)	209.7 (72%)	167.0 (67%)
Natural gas liquids	2,577 (85%)	2,389 (85%)	22.4 (82%)	20.6 (82%)
Coal	8,060 (53%)	8,458 (50%)	1,974.8 (18%)	1,988.5 (17%)
Hydropower	151 (16%)	183 (18%)	0.4 (22%)	0.4 (21%)
Nuclear	57 (10%)	221 (29%)	0.2 (16%)	1.0 (28%)
Total	46,237 (72%)	42,235 (68%)	2,319.1 (20%)	2,269.7 (19%)

Between 1972 and 1975 the region's share of nuclear generation of electricity increased almost three-fold. Texas is the only state in the region with active uranium deposits, but Florida has some uranium oxide deposits in its phosphates. Tennessee and Kentucky have two of the three uranium enrichment facilities in the United States.

Since 1972 the region's share of national energy production has declined by 4%. These declines in fossil energy production were not offset by the absolute and relative increases in hydro and nuclear generation of electricity. These statistics indicate that the long era of the dominance of the South in energy production may be drawing to an end as extensive oil and gas reserves are depleted to meet ever increasing demands for energy.

The South not only produces a large amount of energy; it has also been a relatively high user of energy in the past. Per capita consumption of total energy in 1974 was 14% higher than the national average. Table II compares energy utilization patterns of the South with the nation by sector and fuel in 1974. Per capita fuel usage by sector is related to that of the nation, with a ratio of unity indicating comparable patterns. The residential-commercial sector accounted for 34% less per capita energy than its non-South counterparts. The utilities sector used 22% more, the transportation sector 13% more, and the industrial sector 40% more energy per capita than the national average. This is particularly important in that proper adjustment (of the statistics on energy usage) for regional variances in industrial mix indicate that energy consumption patterns of the South may not be radically different from those of other regions.

Table II. Per capita energy use in the South relative to the Nation^a

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	0.56	0.64	0.67			0.66
Industrial	0.68	0.93	1.99			1.40
Electric utilities	1.19	0.95	2.30	0.51	0.95	1.22
Transportation		1.10	1.86			1.13
Other		0.94				
Total	1.01	0.97	1.58	0.51	0.95	1.14

^aBased on population estimates of 61,923,000 in the South and 211,445,000 in the United States.

The relatively low usage of the residential-commercial sector is consistent with the fact that per capita income is 14% less than the national average and there are 46% fewer mean heating degree days in the South. The high relative usage of the industrial sector is to be expected given the large number of refineries, processing plants, and chemical industries. The transportation sector used 86% more natural gas than was typical, primarily as a compressor fuel for pipeline transmission of natural gas to other regions. The utilities use over twice the amount of natural gas for electrical generation than utilities in other regions. This has been primarily a function of the availability of natural gas and is expected to change as utilities are forced to convert to coal.

With this overall view of energy production and usage in mind, we now turn to a more detailed examination of the energy inputs to gain insight into the probable bases for the observed consumption patterns. The inputs to be examined are natural gas, crude oil, and coal. The energy outputs include the refined outputs of petroleum refineries and natural gas processing plants, as well as electricity generated from fossil fuels, hydro, or nuclear sources. These energy inputs and outputs are summarized by state in Appendices B and C.

We will then examine the demand for energy by sector and by fuel, the sectors being defined as residential, commercial, industrial, electric utilities, and transportation. The four fuel types are defined as natural gas, coal, petroleum products, and electricity. The energy production and consumption patterns of each state within the South are then presented in a similar framework in the appendices.

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. The South has 26% of its proven gas reserves remaining in 11 of the 34 producing states in the U.S. As is widely known, the estimates of proven reserves represent a minimum rather than optimistic estimate of the total reserves remaining. "Inferred" reserves are defined as extensions and revisions associated with known pools which are usually developed within twenty-five years of the initial discovery. Some reserves are classified as "undiscovered" when it is not likely that they will be developed under existing economic conditions. If we assume that production rates remain at current levels, or that the production rate and reserve increment increase proportionately, we can add the inferred reserves and a mean estimate of the undiscovered resource base to determine a more realistic estimate of remaining natural gas reserves. The statistics indicate then that the South has sufficient natural gas resources through 2005. Currently the region is exporting 42% of the natural gas it produces. These reserves would, of course, be available beyond 2005 if the rate of export to other states were reduced. Figure 1 charts the production history of natural gas in the South.

Figure 1. Natural gas production in the South.
(ft³ x 10⁶)

The natural gas pipeline network of the region is extensive (see Figure 2). In the South Atlantic region, Transcontinental Gas Pipeline connects Washington, D.C. and Atlanta with the Gulf Coast gas fields; in the West, El Paso Natural Gas links the Gulf Coast and California; while the Natural Gas Pipeline Company of America links the Midwest with the Panhandle and Hugoton fields. In the East South Central region the pipeline network has a northeast-southwest orientation with several parallel lines connecting northwestern Kentucky with Nashville and the gas fields of Louisiana and East Texas.

Table III indicates the interstate pipeline movements for the region in 1975. Marketed production has declined since 1972 as have interstate shipments of natural gas to other regions. Though Ohio shipped some gas to West Virginia, this state was a net importer of natural gas from the South. It is noteworthy that only Texas, Louisiana, and Oklahoma currently produce more natural gas than they consume. The only net foreign shipments of natural gas of the region are to Mexico. The pipeline, of course, is the cheapest and most important mode of natural gas transport, though gas may also be shipped in liquefied form via truck or tanker.

Table III. Interstate pipeline shipments of natural gas
in the South in 1975

	Amount (ft ³ x 10 ⁹)
Marketed production	16,676
Net shipments	7,056
26.0% to Kansas	
16.0% to Indiana	
14.5% to Ohio	
10.1% to Missouri	
9.5% to Pennsylvania	
9.5% to Maryland and D. C.	
7.5% to New Mexico	
5.3% to Illinois	
1.1% to Colorado	
0.1% to Mexico	
Retained for regional use	9,620
Regional consumption	9,414
Change in storage	112

Fig. 2. Natural gas pipelines in the South.

Interstate prices of natural gas have been regulated by the Federal Power Commission since 1954. Excess demand has increased and curtailments are becoming increasingly severe. The FPC projected natural gas shortages during the winter of 1975-1976 in several states. Table IV indicates these projections and how they changed from the previous year.

Table IV. Projections of natural gas shortage in 1975-1976

State	Total curtailment		Increase in curtailments from 1974-1975 (%)
	ft ³ x 10 ⁹	% of requirements	
Florida	50	49	10
Georgia	63	29	11
Kentucky	13	10	6
North Carolina	41	46	6
South Carolina	59	55	4
Tennessee	31	22	9
Virginia	12	14	-1
West Virginia	12	13	3

Crude Oil. In 1975 there were 32 states producing crude oil, 11 of which were located in the South which has 17% of its oil reserves remaining. "Indicated" reserves are defined by the U.S. Geological Survey as those which will be proven as soon as tertiary techniques (such as fluid injection) are employed. By adding the estimates of inferred and indicated reserves and a mean estimate of the undiscovered reserves to the measured reserve base, it appears that the South has oil remaining until 1998, assuming that production continues at the 1975 rate. The production history of crude oil in the South is charted in Figure 3. Table V shows that both the region and the nation as a whole are net importers of crude oil (approximately 23% of crude runs to stills by refiners in 1975 was foreign crude). In 1972 the South was a net exporter of crude oil.

In the South Atlantic region there are two parallel oil pipelines connecting Washington, D.C. and Baltimore with Greensboro, Atlanta, and the Gulf Coast oil fields. Another major oil line crosses western Kentucky, Tennessee, and northwestern Mississippi, while a third connects Knoxville and Chattanooga with Birmingham, then extends to the oil fields of the Louisiana Gulf. Approximately 60% of the crude gathering line mileage and 61% of the crude trunk line mileage of the nation is located in the South.

Figure 3. Crude oil production in the South
(bbl x 10³)

Table V. Interstate shipments of crude oil in the South in 1975

	1972	1975
	bbl x 10 ⁶	
Production	2520	2165
Receipts	132	517
94.2% from foreign sources		
2.6% from New Mexico		
1.6% from Illinois, Indiana, & Michigan		
0.7% from Utah		
0.3% from Colorado		
0.2% from Kansas		
0.4% from Wyoming, Ohio, & California		
Shipments	641	515
36.9% to Illinois		
22.1% to Ohio		
17.0% to Indiana		
9.3% to Kansas		
5.5% to Missouri & Nebraska		
3.4% to Pennsylvania		
2.3% to New Jersey		
1.4% to Michigan		
0.9% to Delaware & Maryland		
0.8% to New York		
0.3% to Minnesota & Wisconsin		
Retained for regional use	2011	2167
Change in stocks	0	4
Refinery loss	0	1
Regional consumption ^a	2001	2157

^aThe consumption of crude oil is that of refiners who use it as an input in the production of gasoline, fuel oil, etc. Unlike natural gas, the Bureau of Mines reports crude shipments only by refining regions. It was not possible, therefore, to separate some of the shipments into single-state components.

While the pipeline is the primary mode of transport, its role varies across regions and ultimate destinations. Table VI indicates the South is somewhat more reliant upon tanker and barge transport than the U. S. for its interstate and foreign shipments. About 70% of all intrastate shipments of crude oil were in the South, which accounted for half the shipments of oil in 1975. Of the total crude oil shipped in the region, 69% was shipped via pipeline and 30% via tanker or barge.

Table VI. Transport modes of crude oil shipments in the South and the United States in 1975^a

Shipment type	South	United States	Share (%)
Interstate	396	1215	32.6
Percentage by:			
Pipeline	76.9	84.0	
Truck or rail	0.8	2.0	
Tanker or barge	22.3	14.0	
Intrastate	1279	1832	69.8
Percentage by:			
Pipeline	90.1	89.6	
Truck or rail	2.2	3.1	
Tanker or barge	7.7	7.4	
Foreign	487	1498	32.5
Percentage by:			
Pipeline	6.8	26.5	
Tanker	93.2	73.5	
Total	2162	4545	47.6
Percentage by:			
Pipeline	68.9	67.3	
Truck or rail	1.5	1.8	
Tanker or barge	29.6	30.9	

^aCrude oil is expressed in thousands of 42-gallon barrels.

Coal. Ten of the twenty-five coal-producing states are located in the South. The region accounts for approximately half of total U.S. coal production with 76% of the coal mines (56% of the strip mines) in the United States in 1975. West Virginia and Kentucky are the region's leading producers; Virginia and Arkansas are the only southern states with anthracite reserves.

The availability of data on the transportation of coal is limited to final destinations and shipments. Table VII presents the data on total coal production, marketed production, receipts of coal, and coal consumption for 1975.

Table VII. Interstate shipments of bituminous coal and lignite in the South in 1975

	Millions of short tons
Total production	
Marketed production (shipments)	305
	Rail, 77%
	Water, 13%
	Truck, 10%
Kentucky, 44.1%	
West Virginia, 33.8%	
Virginia, 11.6%	
Alabama, 6.6%	
Tennessee, 2.6%	
Oklahoma, 0.9%	
Arkansas, 0.2%	
Texas & Georgia, 0.1%	
Non-marketed production	28
	Mine-mouth plants, 92.7%
	Other, 7.3%
Texas, 35.2%	
Kentucky, 32.9%	
West Virginia, 22.1%	
Alabama, 9.2%	
Tennessee, 0.5%	
Arkansas, Oklahoma, & Virginia, 0.1%	

Table VII (continued)

	Millions of short tons
Received	186
West Virginia, 19.5%	
Alabama & Mississippi, 18.1%	
Kentucky, 16.5%	
North Carolina, 12.9%	
Tennessee, 12.8%	
Florida & Georgia, 10.7%	
Virginia, 4.8%	
South Carolina, 4.2%	
Arkansas, Texas, Louisiana & Oklahoma, 0.6%	
Consumption ^a	186
	Electric utilities, 83.5%
	Coke & gas plants, 7.4%
	Retail dealers, 0.7%
	Other, 8.4%
West Virginia, 18.5%	
Kentucky, 15.3%	
Alabama, 15.2%	
Tennessee, 14.3%	
North Carolina, 11.5%	
Georgia, 8.1%	
Texas, 6.7%	
Virginia, 3.5%	
South Carolina, 3.0%	
Florida, 2.9%	
Mississippi, 0.9%	

^aIncludes 9000 tons of anthracite consumed in Virginia and 57,000 tons of anthracite consumed in West Virginia. Net shipments of coal for 1975 are presented in the appendix.

The South shipped 77% of its bituminous coal and lignite by rail, 13% by barge, and 19% by truck. The railroad system of the South Atlantic region has a distinct northeast-southwest orientation with the secondary interconnecting lines running east-west. The major weakness in the energy transport network is in some of the railroad facilities serving the coal fields of West Virginia. If coal production is to be increased in this state, improvements in the existing railroad lines, rolling stock and facilities will be required. Most of the railroads in the East South Central region have a north-south orientation due to the configuration of the Appalachian mountains and the Mississippi Valley. The railway network of the West South Central region is adequate at present for fossil energy transport, but if coal conversion plants are opened in the region, additional spur tracks might be required (unless these conversion plants are mine-mouth facilities). It is possible, of course, that the use of scrubbers (best available control technology) or fluidized bed combustion techniques will minimize the problems associated with burning high sulfur eastern coal. This would then lead to a decline in the demand for western coal and the associated need to expand the railway network.

Electric utilities consumed 84% of the bituminous coal in the South in 1975, and coke and gas plants an additional 7%. West Virginia, Kentucky, and Alabama are the largest coal consumers in the South. Virginia was the major foreign exporter of coal in 1975. Appendix D indicates the net shipments of coal to utilities with at least 25 megawatts in 1975. Both the region and the nation exported more coal than they imported.

Hydro-Nuclear. There are 138 counties in the South which have hydro generation facilities; the bulk of the capacity is in Tennessee and Alabama. The South has only 21% of the total hydro capacity. Most hydro generation is in the Pacific-Northwest. Not all of the hydro potential has been completely developed, but it is not likely that hydro will ever play a substantial role in supplying energy to the South. The hydro producing counties are listed in Appendix F.

Nuclear generation is becoming increasingly important to the nation. In 1972 only three states in the South had nuclear facilities, and the region had only 16% of the nuclear capacity. In 1975 the region's share increased to 28% of the total capacity with 7 of the 41 nuclear plants in operation. West Virginia and Kentucky are the only states in the South which are not expected to have nuclear generation of electricity in 1985. The location of the existing nuclear facilities is shown in Figure 4.

Fig. 4. 1975 total sited capacity of nuclear power plants in megawatts (by county) .

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products - Refineries. There were 256 operating refineries in 1975 in 38 states; 100 of these refineries are located in the South. The region accounted for 47% of the total refinery capacity and 48% of the total crude oil refined in 1975. The nation as a whole must import refined products (10% of all refined products consumed in 1975 were imported from abroad), particularly residual oil. The dependence upon foreign imports of petroleum products declined between 1972 and 1975, while the dependence upon foreign imports of crude oil increased 3%. The South is a net exporter of major refinery products, though it too is a net importer of residual oil. The region has 38% of the total pipelines in the nation with each state having access to at least one product pipeline. Of all refined products shipped in the nation, 34% are shipped via pipeline, 40% by rail or truck, and 26% by tanker or barge.

Petroleum Products - Natural Gas Processing Plants. The South had 76% of the 754 natural gas processing plants in 1975 located in 9 of the 24 states with such plants. The region accounted for 81% of capacity and 81% of actual gas throughput. Gas processing plants use lease condensate (a natural gas liquid) as an input to produce liquid petroleum gas, butane, propane, natural gasoline, etc. Some of the lease condensate is shipped to refineries which use the refined liquid gas output as a feedstock. Natural gas liquids are also defined to include the outputs of refineries and processing plants from natural gas and lease condensate. Of the total natural gas liquids processed by refineries and processing plants, the South accounted for 82% of the total. Both the region and the nation are net exporters of natural gas liquids.

Electricity. The technique of electrical generation varies regionally reflecting the varying availabilities of fuels. Table VIII indicates that both the region and the nation rely on conventional steam generation from fossil fuels for the bulk of the electricity generated. With 836 of the 3,623 plants in the U.S., the region generated over 37% of the total electricity. The South has 52% of the industrial establishments which generate their own electricity. The location of the coal, oil, and gas-fired capacity in the region is illustrated in Figures 5, 6, and 7, respectively.

As previously noted, nuclear generation is becoming increasingly more significant in the South. In 1972 less than 1% of the electricity generation was from nuclear sources, but by 1975 this share had increased to 7%. The utilities do appear to be switching away from oil and gas generation toward coal and nuclear. Electricity exports by the states in the South are shown in Appendix G.

Fig. 7. 1975 total sited capacity of gas-fired electric plants in megawatts [by county]

Table VIII. Electricity generation in the South in 1975

Ownership	Number of plants		Generation mix		Share of United States
	South	United States	South	United States	
Industrial establishments	256	844			51.6%
Conventional steam	187	599	85.8%	88.3%	
Hydropower	25	128	1.8%	3.9%	
Internal combustion	32	101	7.6%	4.7%	
Gas turbine	12	16	4.8%	3.1%	
Electric utilities	836	3623			37.3%
Conventional steam	320	984	84.3%	73.9%	
Hydropower	225	1155	7.7%	15.7%	
Internal combustion	145	936	0.2%	0.3%	
Gas turbine	139	507	1.0%	1.2%	
Nuclear	7	41	6.8%	9.0%	

More efficient power plant technology, the implementation of coal gasification, the use of high-sulfur coal in atmospheric fluidized beds, and other technologies may further reduce the dependence of the region upon natural gas. A technology of major importance to the South is the use of coal to produce synthetic gas for chemical feedstocks. Slurry and coal-gas pipelines may prove particularly significant for electric utilities if institutional and environmental constraints can be overcome.

THE DEMAND FOR ENERGY

One of the most important determinants of total energy usage is the size of the consuming population. Table IX indicates that Louisiana is the highest per capita net energy user in the South, and the second highest user in the nation. Texas is also a large energy user, while Florida is the smallest energy user on a per capita basis. Both Texas and Louisiana, of course, are heavily involved in petroleum and gas refining and in the manufacturing of chemicals.

Before examining the demand for energy by individual sector, however, it is useful to summarize the fuel mix of each sector in the region and its total BTU consumption of energy. Table X indicates the region's dependence upon natural gas and petroleum. Table XI shows that while the region uses both natural gas and petroleum more than other fuels, it is atypical only in its use of natural gas. The electric utilities and industries are especially reliant upon natural gas relative to other regions.

The South now consumes more energy on a total and per capita basis than it did in 1972, while national energy consumption has declined somewhat. Per capita energy usage in the region changed very little between 1972 and 1975. The relative fuel mix has remained about the same, with the dependence upon hydro and nuclear sources increasing, but remaining less than the national average.

Residential. Ratios of the demand of the residential sector for energy in the South relative to the nation as well as prices paid regionally for specific fuels is shown in Table XII. Electricity is the most expensive fuel in the region, but is 12% cheaper in the South on average. (Not all states in the South are homogeneous, of course, and differences in prices paid by each state are shown in the appendices.) On a per capita basis, residents of the South use electricity 29% more than the national average. Both natural gas and fuel oil usage are less than the national average, with natural gas prices 12% cheaper in the South than the rest of the nation, and fuel prices approximately the same. Energy prices in general have increased over the past few years, the price of electricity in the South increasing 43% between 1972 and 1975, that of natural gas increasing 39%, and fuel oil prices doubling.

Table IX. Per capita energy use in the South

State	Population		Per capita use (Btu x 10 ⁶)	
	1972	1975	1972	1975
Louisiana	3,738	3,791	716.4	799.7
Texas	11,604	12,237	589.5	613.3
West Virginia	1,795	1,803	632.9	571.6
Oklahoma	2,633	2,712	390.5	419.0
Alabama	3,521	3,614	414.4	395.1
Kentucky	3,306	3,396	382.5	342.8
Arkansas	2,008	2,116	325.1	320.4
Tennessee	4,072	4,188	315.6	308.5
Mississippi	2,256	2,346	305.4	296.7
South Carolina	2,688	2,818	272.7	288.5
Georgia	4,733	4,926	290.3	273.2
Virginia	4,765	4,967	253.6	251.9
North Carolina	5,221	5,451	267.7	233.4
Florida	7,347	8,357	216.6	228.0
South	59,687	62,722	391.0	391.4
United States	208,230	213,121	346.3	318.8

Table X. Fuel mix by sector in the South in 1974

Sector	Percentage					Total (Btu x 10 ¹²)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	1.8	42.7	55.5			2,669
Industrial	10.0	19.4	70.6			8,244
Electric utilities	41.6	13.6	33.1	7.0	4.7	7,112
Transportation		93.9	6.1			6,071
Other	2.3	97.7				67
Total	15.9	39.2	41.5	2.0	1.4	24,165

Table XI. Fuel mix by sector in the South in 1974
relative to the United States

Sector	Coal	Oil	Gas	Hydropower	Nuclear
Residential commercial	0.86	0.97	1.03		
Industrial	0.49	0.66	1.41		
Electric utilities	0.98	0.78	1.88	0.43	0.77
Transportation		0.98	1.65		
Other		1.00			
Total	0.89	0.85	1.39	0.43	0.77

Table XII. Fuel use of the residential sector
in the South in 1975

	Southern residential sector relative to the nation	Fuel prices (\$/10 ⁶ Btu)	Ratio of prices
Electricity	1.29	8.25	0.88
Natural gas	0.63	1.47	0.88
Fuel oil	0.33	2.61	1.01
Gasoline	1.10	4.49	0.98
Kerosene	1.60	2.98	1.02

There is a myriad of factors affecting energy utilization and the importance of each factor varies. A fairly sophisticated approach is required to ascertain the particular impact of per capita income, climate, characteristics of the housing stock, capital costs, relative fuel prices, etc. Energy demand by end use can be determined by applying a utilization factor for each fuel to specific information as to capital stock characteristics (the size and type of housing units, the thermal efficiency of the capital equipment, the replacement cost of the capital equipment, etc.) From the annual census of housing, one can estimate the size and type of housing units. By then estimating the market share of each type of fuel-using equipment and employing an average utilization factor, one can determine end use patterns of energy consumption. The residential energy model developed at ORNL by Eric Hirst provides these estimates of end use for census regions in 1975. These are shown in Table XIII for the South Atlantic, East South Central, and West South Central census regions.

The South, in general, uses more energy for air conditioning than do other regions of the nation. The West South Central region is particularly unique in this regard. The high use of electricity in the region, due primarily to the air conditioning load, is a consequence of availability of electric power from the Tennessee Valley Authority. As was previously shown, electricity prices are relatively cheaper in the South than elsewhere.

Conservation technologies in air conditioning, heating, and building construction can help reduce demand significantly in this sector. Significant improvements in technical efficiencies of household equipment and improvements in thermal integrity of existing structures (consistent with ASHRAE standards) could well yield a decline in per household fuel use. This, of course, is contingent upon increasing fuel prices as a motivating factor for implementation of conservation strategies.

Commercial. Approximately 27% of the nation's commercial employees reside in the South, where commercial employment accounts for about 63% of the total employment. Table XIV shows the fuel mix of this sector and compares it with the national average. The sector's use of electricity is relatively high and is primarily attributed to the air conditioning load. Both electricity and natural gas prices paid on average by the sector are 15% cheaper than elsewhere in the nation. Standardizing for differences in employment across regions, it is shown that per employee usage of electricity is 19% higher than the national average, and fossil fuel usage lower. Per employee usage of natural gas is 17% lower and that of fuel oil 35% lower than is true nationwide of the commercial sector.

The West South Central region is unique in that its commercial sector is particularly reliant upon natural gas and electricity while the South Atlantic region is particularly reliant upon fuel oil and electricity. Relative prices paid for electricity by commercial users have declined slightly since 1972 (from 13% less than the national average to 14% less than the national average).

Table XIII. Fuel use per residential user by end use in the South in 1975

Fuel mix and end use	Percentage		
	South Atlantic	East South Central	West South Central
Electricity	61.6	63.7	58.2
Natural gas	19.7	23.9	35.3
Oil	12.4	3.5	1.8
Other	6.3	8.9	4.7
Total	100.0	100.0	100.0
Space heating	45.6	46.4	33.0
Water heating	18.8	14.9	12.6
Air conditioning	11.6	9.8	20.0
Refrigeration	6.7	5.3	6.5
Lighting	6.5	5.3	7.0
Cooking	6.0	5.1	5.1
Freezers	2.9	2.9	3.4
Other	1.9	10.4	12.5
Total	100.0	100.0	100.0
Total Btu (quadrillions)	21.6	10.4	13.9
Population (millions)	28.3	13.5	20.9

Table XIV. Fuel use by the commercial sector in the South in 1975

Fuel	Fuel mix (%)	Ratio of mix	Fuel price (\$/10 ⁶ Btu)	Ratio of price	Ratio of per employee share
Oil	30.4	0.78	2.61	1.01	0.65
Gas	34.6	1.00	1.11	0.84	0.83
Coal	3.0	0.74			0.61
Electricity	28.6	1.44	7.98	0.86	1.19

Industrial. The South has 29% of the industrial employees in the nation. Table XV indicates the fuel mix of this sector and relative fuel prices. The sector has a particularly heavy reliance upon natural gas, particularly industry in the West South Central region. The relative prices of oil, gas, and electricity are less than those paid by industrial users elsewhere in the nation. On a per employee basis, it is seen that the industrial sector uses twice as much gas as the national average and 29% more electricity. The relatively high use of electricity is primarily in the East South Central region.

The industrial sector of the West South Central region uses almost half of the energy consumed in the region and is 76% dependent upon natural gas. Industry in the South Atlantic region uses 9% of the fuel oil used by the region and is almost three times as dependent upon oil as the East South Central region. The latter region is 24% dependent upon electricity, while the West South Central region is only 5% dependent upon electricity (the national average for this sector is 11% dependent upon electricity).

Table XV. Fuel use by the industrial sector in the South in 1974

Fuel	Fuel mix (%)	Ratio of mix	Fuel price (\$/10 ⁶ Btu)	Ratio of price	Ratio of per employee share
Oil	22.2	0.76	1.71	0.89	1.07
Gas	59.9	1.40	0.51	0.84	1.97
Coal	8.7	0.49	1.02	1.18	0.73
Electricity	9.2	0.91	3.82	0.84	1.29

The employment mix within the industrial sector is important to the determination of actual fuel mix and the regional share of energy utilization by the sector. The sector is defined to include mining, construction, and manufacturing. In the South approximately one-fourth of the employment and earned income is from manufacturing. Table XVI shows the fuel mix and usage of the manufacturing sector in the South in 1974. As was true of the industrial sector as a whole, per employee usage of natural gas and electricity is higher than the national average while relative prices paid are lower. Only the price of coal is relatively higher in the South than elsewhere. Note that the average price of energy is 20% less in the South than in any other region of the nation.

Table XVI. Fuel use by the manufacturing sector in the South in 1974

Fuel	Fuel mix (%)	Ratio of mix	Fuel price (\$/10 ⁶ Btu)	Ratio of price	Ratio of per employee share
Oil	9.7	0.75	1.71	0.89	1.17
Gas	61.0	1.24	0.57	0.85	1.95
Coal	7.3	0.78	1.02	1.18	1.23
Electricity	14.1	0.90	3.47	0.86	1.41
Coke	1.1	0.42	1.49	0.97	0.65
Total	93.3		1.16	0.80	1.57

Table XVII indicates the per employee electricity and total energy usage of each 2-digit SIC in the nation. The industries are also ranked in terms of relative energy-intensiveness. The chemical and petroleum industries are the highest energy users while the apparel industry is the smallest energy user. The employment mix of each state in the South was determined and weighted by the average energy user per employee in each SIC. This index (shown in Table XVIII) indicates the South is on the average more energy intensive than the rest of the U.S. based on the composition of its manufacturing sector.

Table XVII. Energy use for heat and power by 2-digit SIC in the U.S. in 1974^a

SIC	Industry	Employment (x 10 ³)	Electricity use per employee	Total energy use per employee	Rank
20	Food	1713	0.022	0.164	6
21	Tobacco	80	0.013	0.074	11
22	Textile	988	0.027	0.096	9
23	Apparel	1348	0.005	0.014	20
24	Lumber	626	0.024	0.127	7
25	Furniture	517	0.008	0.033	17
26	Paper	702	0.058	0.556	5
27	Printing	1112	0.008	0.024	18
28	Chemicals	1057	0.117	0.812	2
29	Petroleum and coal	199	0.137	2.309	1
30	Rubber and plastics	676	0.028	0.111	8
31	Leather	278	0.005	0.024	19
32	Stone, clay, and glass	690	0.042	0.567	4
33	Primary metal	1344	0.122	0.576	3
34	Fabricated metal	1505	0.017	0.080	10
35	Machinery	2218	0.012	0.049	13
36	Electrical equipment	2030	0.012	0.036	15
37	Transportation equipment	1821	0.016	0.060	12
38	Instruments	520	0.009	0.040	14
39	Miscellaneous	448	0.009	0.033	16
Average			0.031	0.197	

^aElectricity is expressed in millions of kilowatt hours per year and fossil fuels are expressed in millions of kilowatt hour equivalents per year.

Table XVIII. Energy-intensiveness indices of manufacturing in the South in 1974

SIC	Employment (x 10 ³)	Oil	Coal	Gas	Electricity	Total energy
20	439	0.66	0.18	1.00	0.99	0.82
21	58	1.19	0.32	1.46	1.22	1.24
22	709	0.83	1.35	1.16	1.20	1.06
23	584	0.50	2.08	1.14	0.95	0.94
24	287	0.90	1.61	1.11	0.83	0.95
25	227	0.96	1.58	1.23	1.02	0.88
26	181	1.88	1.20	2.14	1.28	1.67
27	212	0.44	0.00	1.25	1.08	0.90
28	332	1.30	1.91	2.55	1.95	2.17
29	60	1.57	0.00	2.38	1.46	2.17
30	153	1.09	0.38	1.46	1.20	1.09
31	55	0.24	0.38	0.56	1.42	0.99
32	207	0.84	0.36	1.24	1.05	1.08
33	204	0.41	2.15	1.69	1.93	1.48
34	311	0.35	0.53	0.76	0.93	0.81
35	351	0.34	1.12	1.83	1.18	0.99
36	380	0.59	0.62	1.13	1.27	1.07
37	291	0.74	0.12	0.68	0.81	0.66
38	63	0.62	0.01	3.38	1.34	1.12
39	82	0.33	0.96	0.93	1.01	0.81
Average		0.79	1.25	1.99	1.44	1.60

This energy index assumes that those industries which are large per employee users of energy nationally use similar input mixes regardless of regional location. Such an assumption overlooks possible variations in input mix which arise from differing availabilities of labor and capital and other raw materials. This assumption is removed when each region is examined individually and indices for each 2-digit SIC are presented. The latter indices, presented in Table XVIII, indicate that on average the manufacturing industries of the South use 60% more energy per employee than manufacturing industries in other regions of the nation. The chemicals and petroleum industries, in particular, use over twice as much energy per employee as do those industries in other parts of the U. S. The manufacture of transportation equipment in the South, however, requires 34% less energy per worker than elsewhere.

Note, moreover, that natural gas usage by the manufacturing sector of the South is about twice as high as the national average, while electricity usage per employee is 41% greater, coal usage per employee is 23% greater, and fuel oil usage per employee is 17% greater than the national average.

Industrial growth in the South Atlantic region is projected to increase 78% between 1971 and 1985, while growth in the East South Central region is projected at 79% and that in the West South Central region at 82% relative to a national increase of 64%. Whether or not energy usage by the industrial sector of the South will increase commensurately will depend largely upon the employment mix of this new industry. The National Energy Plan should play a significant role in ensuring that new industries employ coal rather than natural gas or fuel oil.

Table XIX. Fuel use by the electric utility sector in the South in 1975

Fuel	Fuel mix (%)	Ratio of mix	Fuel price (\$/10 ⁶ Btu)	Ratio of price	Ratio of share
Petroleum	11.0	0.73	1.86	0.93	0.92
Natural gas	31.2	2.00	0.79	1.06	2.53
Coal	43.4	0.98	1.00	1.16	1.24
Hydropower	7.5	0.48			0.61
Nuclear	6.9	0.76			0.97
Total	100.0		1.04	0.96	1.27

Electric Utilities. As shown in Table XIX, the utilities of the South were primarily dependent upon coal for electrical generation, but relative to utilities elsewhere had a high mix of natural gas. Natural gas prices paid by the sector were 6% higher than elsewhere in the nation, coal prices 16% higher on average, and oil prices 7% less. Overall, the cost of generating a kilowatt hour of electricity was 4% less in the South than in the rest of the nation. On a per capita basis, the utilities sector used over twice as much natural gas as the national average, 24% more coal, and 8% less fuel oil for electrical generation. Nuclear generation is now approximately the same, on a per capita basis, as elsewhere. Per capita energy usage of the sector was 27% higher in the South than in other regions of the U. S.

Transportation. The transportation sector of the South Atlantic region uses 30% of the total energy consumed there, while the transportation sector of the East South Central region uses 27% and that of the West South Central region uses 21% relative to a national average of 25%. In the South Atlantic region, this sector consumes 56% of all oil consumed, while in the East South Central region, this sector consumed 72% of the oil. Conservation in ship, aircraft, and vehicular transport could reduce this level of dependence. The 10% dependence upon natural gas in the East South Central region is primarily a consequence of the large quantities consumed in compressing natural gas for pipeline transport. Table XX indicates the fuel usage of this sector in 1975.

Table XX. Fuel use by the transportation sector in the South in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Per capita energy use relative to the nation
Petroleum	95.2	0.98	4.49	0.98	1.16
Natural gas	4.8	1.53	0.37	0.94	1.79
Total	100.0				1.18

Overall, the South has more than its per capita share of tons carried in waterborne commerce and vehicle and locomotive miles. These stock characteristics are then consistent with the above average share of energy usage by the transportation sector.

SUMMARY AND CONCLUSIONS

Since 1972 energy production in the South has declined absolutely and relative to the nation, while energy consumption has increased both in total and on a per capita basis. Because the region is so important for oil and gas supplies, the declining rate of production is a major concern. Secondary and tertiary extraction technologies are of primary importance. Drilling and exploration is receiving increased emphasis in an attempt to locate and efficiently develop additional reserves. Technological advances in offshore drilling are important for the continued development of the Gulf of Mexico and portions of the Atlantic coast.

Major energy savings in the residential and commercial sectors can be achieved through enhanced conservation strategies given the favorable climate of the region. The South, of course, is an ideal region for implementation of solar energy systems for use in both heating and cooling. As oil and natural gas reserves are depleted and the hydro potential is developed, the region must be prepared for alternative energy sources such as coal, geothermal, solar, and nuclear.

The South is projected to be a high economic growth area, particularly the South Atlantic region. Economic activity is projected to increase 81% in the South Atlantic, 79% in the East South Central region, and 72% in the West South Central region relative to a national increase of 73%. Energy availability may influence whether this growth is actually attained.

II. APPENDICES

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APPENDIX A

GENERAL ECONOMIC CHARACTERISTICS OF THE SOUTH IN 1975

State	Population ($\times 10^3$)	Land area (sq miles)	Per capita income (1975 \$)	Employment ($\times 10^3$)	Heating degree-days
Alabama	3,614	50,708	4,557	1,150	1,257
Arkansas	2,116	51,945	4,383	620	1,875
Florida	8,357	54,090	5,517	2,730	348
Georgia	4,926	58,073	4,969	1,725	1,308
Kentucky	3,396	39,650	4,668	1,042	2,453
Louisiana	3,791	44,930	4,729	1,199	940
Mississippi	2,346	47,296	4,041	667	1,253
North Carolina	5,451	48,798	4,801	1,996	1,660
Oklahoma	2,712	68,782	4,996	887	2,088
South Carolina	2,818	30,225	4,521	978	1,298
Tennessee	4,188	41,328	4,766	1,497	1,938
Texas	12,237	262,134	5,387	4,413	1,122
Virginia	4,967	39,780	5,671	1,755	2,092
West Virginia	1,803	24,070	4,815	561	2,697
South	62,722	861,809	5,019	21,220	1,595
United States	213,121	3,536,855	5,834	76,985	2,972

APPENDIX B

FOSSIL ENERGY PRODUCTION AND RESERVES IN THE SOUTH IN 1975

State	Production				Proved Reserves			
	Coal (tcms × 10 ⁶)	Oil (bbl × 10 ⁶)	Gas (ft ³ × 10 ⁹)	NGL (bbl × 10 ⁶)	Coal (tcms × 10 ⁶)	Oil (bbl × 10 ⁶)	Gas (ft ³ × 10 ⁹)	NGL (bbl × 10 ⁶)
Alabama	22.6	13.5	37.8	6.5	2,981.8	61.0	771.0	251.3
Arkansas	0.5	16.1	116.2	.8	665.7	95.7	1,993.3	3.9
Florida	0.0	41.9	44.4	7.1	0.0	252.5	266.9	45.7
Georgia	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
Kentucky	143.6	7.6	60.5	3.1	25,540.6	39.3	812.6	42.7
Louisiana	0.0	650.8	7,090.6	198.7	0.0	3,827.2	61,309.4	1,717.7
Mississippi	0.0	46.6	74.3	1.4	0.0	231.2	1,207.6	15.2
North Carolina	0.0	0.0	0.0	0.0	31.7	0.0	0.0	0.0
Oklahoma	2.9	163.1	1,605.4	41.9	1,294.2	1,239.7	13,083.0	299.2
South Carolina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tennessee	8.2	0.7	0.0	0.0	986.7	1.5	6.6	0.0
Texas	11.0	1,221.9	7,485.8	327.4	3,271.9	10,030.0	71,036.9	2,660.7
Virginia	35.5	N	5.7	0.0	3,648.7	0.0	47.5	0.0
West Virginia	109.3	2.5	154.5	5.7	39,589.8	31.4	2,311.3	82.5
Total								
South	333.6	2,164.7	16,675.3	592.6	78,012.6	15,855.5	152,846.1	5,118.9
United States	648.5 (51.5%)	3,056.8 (70.8%)	20,103.7 (82.3%)	701.1 (84.5%)	436,725.4 (17.9%)	32,632.1 (48.6%)	228,200.2 (67.0%)	6,267.8 (81.7%)

APPENDIX C

ENERGY PROCESSING IN THE SOUTH IN 1975

State	Crude oil		Natural gas		Electricity	
	No. of refineries	Capacity (bbl × 10 ⁶ /day)	No. of plants	Capacity (10 ⁶ ft ³ /day)	No. of plants	Capacity (GW)
Alabama	3	49.9	3	37.5	37	15.2
Arkansas	4	60.8	2	138.0	35	4.7
Florida	1	5.7	2	990.0	92	21.7
Georgia	2	18.0	0	0.0	54	12.1
Kentucky	3	164.0	2	895.0	33	12.1
Louisiana	19	1,753.1	112	22,610.0	59	11.6
Mississippi	5	329.5	8	561.7	25	4.0
North Carolina	0	0.0	0	0.0	76	15.0
Oklahoma	12	545.8	81	4,339.8	69	7.9
South Carolina	0	0.0	0	0.0	64	10.8
Tennessee	1	43.9	0	0.0	40	14.3
Texas	46	3,966.3	357	29,021.8	181	40.2
Virginia	1	53.0	0	0.0	50	9.8
West Virginia	3	19.5	4	368.5	21	12.0
South	100	7,039.5	571	58,962.3	836	191.4
United States	256	15,074.8	754	72,697.4	3,623	505.2
	(39%)	(46.5%)	(76%)	(81.1%)	(23.1%)	(37.9%)

APPENDIX D

NET SHIPMENTS OF BITUMINOUS COAL AND LIGNITE TO STEAM-ELECTRIC PLANTS
IN THE SOUTH IN 1975

State and shipments	Thousands of short tons
Alabama	
Exports	1,746.3
Georgia, 83.3%	
Florida, 16.2%	
South Carolina, 0.5%	
Imports	7,685.1
Kentucky, 89.3%	
Tennessee, 5.6%	
Illinois, 4.8%	
Indiana, 0.3%	
Net imports	5,938.8
Intrastate shipments	11,630.6
Arkansas	
Exports	10.4
Kansas, 100.0%	
Net exports	10.4
Intrastate shipments	0.0
Florida	
Imports	5,426.5
Kentucky, 78.0%	
Illinois, 16.8%	
Alabama, 5.2%	
Net imports	5,426.5
Intrastate shipments	0.0
Georgia	
Imports	14,502.0
Kentucky, 75.3%	
Tennessee, 10.2%	
Alabama, 10.0%	
Indiana, 3.3%	
Virginia, 1.1%	
Illinois, 0.1%	
Net imports	14,502.0
Intrastate shipments	0.0
Kentucky	
Exports	76,415.2
Tennessee, 20.9%	
Georgia, 14.3%	
North Carolina, 11.8%	
Ohio, 9.4%	
Alabama, 9.0%	
Michigan, 7.6%	
Florida, 5.5%	
South Carolina, 5.4%	
Indiana, 4.5%	
West Virginia, 3.4%	
Wisconsin, 2.7%	
Pennsylvania, 1.4%	
Virginia, 1.4%	
Mississippi, 0.8%	
New York, 0.7%	
Missouri, 0.4%	
Minnesota, Massachusetts, New Hampshire, New Jersey, Maryland, Iowa, and District of Columbia, 0.8%	

APPENDIX D (continued)

State and shipments	Thousands of short tons
Imports	956.8
Illinois, 82.2%	
Montana, 17.8%	
Net exports	75,458.4
Intrastate shipments	21,664.2
Mississippi	
Imports	1,531.0
Illinois, 58.4%	
Kentucky, 41.6%	
Net imports	1,531.0
Intrastate shipments	0.0
North Carolina	
Imports	19,740.8
Kentucky, 45.8%	
Virginia, 40.9%	
West Virginia, 10.9%	
Tennessee, 2.4%	
Net imports	19,740.8
Intrastate shipments	0.0
Oklahoma	
Exports	1,813.8
Missouri, 75.2%	
Kansas, 16.1%	
Iowa, 3.7%	
Nebraska, 3.1%	
Minnesota, 1.5%	
South Dakota and Illinois, 0.4%	
Net exports	1,813.8
Intrastate shipments	0.0
South Carolina	
Imports	4,479.2
Kentucky, 92.6%	
Virginia, 5.6%	
Tennessee, 1.6%	
Alabama and West Virginia, 0.2%	
Net imports	4,479.2
Intrastate shipments	0.0
Tennessee	
Exports	2,634.8
Georgia, 60.3%	
North Carolina, 19.1%	
Alabama, 17.6%	
South Carolina and Wisconsin, 3.0%	
Imports	19,643.4
Kentucky, 82.1%	
Ohio, 8.5%	
Virginia, 4.2%	
Illinois, 3.7%	
Indiana and West Virginia, 1.5%	
Net imports	17,008.6
Intrastate shipments	4,850.0

APPENDIX D (continued)

State and shipments	Thousands of short tons
Virginia	
Exports	10,912.3
North Carolina, 74.0%	
Tennessee, 7.6%	
West Virginia, 5.5%	
Ohio, 4.8%	
New Jersey, 3.6%	
South Carolina, 2.3%	
Georgia, 1.4%	
Pennsylvania, 0.3%	
District of Columbia, 0.3%	
Indiana, 0.2%	
Maryland and Michigan, 0.1%	
Imports	1,065.5
Kentucky, 100.0%	
Net exports	9,846.8
Intrastate shipments	2,373.7
West Virginia	
Exports	20,793.6
Ohio, 29.6%	
Michigan, 24.6%	
Pennsylvania, 19.4%	
North Carolina, 10.4%	
New Jersey, 6.6%	
New Hampshire, 4.5%	
New York, 4.0%	
Maryland, 0.4%	
Indiana, 0.4%	
Vermont, Minnesota, District of Columbia, Tennessee, Illinois, South Carolina, and Wisconsin, 0.1%	
Imports	3,163.0
Kentucky, 81.1%	
Virginia, 18.9%	
Net exports	17,630.6
Intrastate shipments	21,220.6
South	
Exports	39,986.6
Ohio, 30.4%	
Michigan, 27.3%	
Pennsylvania, 12.9%	
Indiana, 6.9%	
Wisconsin, 5.2%	
New Jersey, 4.7%	
Missouri, 4.2%	
New York, 3.4%	
New Hampshire, 2.3%	
Kansas, Massachusetts, Nebraska, Minnesota, Maryland, South Dakota, Iowa, Vermont, and District of Columbia, 2.7%	
Imports	3,853.5
Illinois, 95.6%	
Montana, 4.4%	
Net exports	36,133.1
Intrastate shipments	70,893.1

APPENDIX E

COAL-PRODUCING COUNTIES IN THE SOUTH IN 1975

Alabama	Oklahoma
Bibb	Craig
Blount	Haskell
Cherokee	LeFlore
Cullman	Muskogee
Dekalb	Nowata
Fayette	Pittsburg
Franklin	Rogers
Jackson	
Jefferson	Tennessee
Lamar	Anderson
Marion	Bledsue
St. Clair	Campbell
Shelby	Claiborne
Tuscaloosa	Cumberland
Walker	Fentress
Winston	Grundy
	Marion
Arkansas	Morgan
Franklin	Overton
Johnson	Putnam
Logan	Roane
Sebastian	Scott
	Sequatchie
Georgia	Van Buren
Chattooga	White
Dade	
	Texas (Lignite)
Kentucky	Freestone
Eastern	Harrison
Bell	Milam
Boyd	Titus
Breathitt	
Carter	Virginia
Clay	Buchanan
Elliott	Dickinson
Floyd	Lee
Greenup	Russell
Harlan	Tazewell
Jackson	Wise
Johnson	
Knott	West Virginia
Knox	Barbour
Laurel	Boone
Lawrence	Braxton
Lee	Brooke
Leslie	Clay
Letcher	Fayette
McCreary	Gilmer
Magoffin	Grant
Martin	Greenbrier
Menifee	Harrison
Morgan	Kanawha
Owsley	Lewis
Perry	Lincoln
Pike	Logan
Pulaski	McDowell
Rockcastle	Marion
Wayne	Marshall
Whitley	Mason
Wolfe	Mercer
	Mineral
Western	Mingo
Buller	Monongalia
Christian	Nicholas
Daviess	Ohio
Edmonson	Preston
Grayson	Raleigh
Hancock	Randolph
Henderson	Taylor
Hopkins	Tucker
McLean	Upshur
Muhlenberg	Wayne
Ohio	Webster
Union	Wyoming
Warren	
Webster	

APPENDIX F. HYDRO-PRODUCING COUNTIES IN THE SOUTH IN 1975

State and Counties			
Alabama	Oconee	McIntosh	Wilson
Autauga	Rabun	Mayes	
Calhoun	Stephens	Muskogee	Texas
Cherokee	Treuthen	Pawnee	Cumberland
Chilton	Union	Sequoyah	Gibson
Covington			Grayson
Elmore	Kentucky	South Carolina	Llano
Lauderdale	Jefferson	Barkeley	Starr
Lawrence	Lyon	Cherokee	Travis
Marshall	Marshall	Chester	Victoria
Talladega	Russel	Fairfield	
Tuscaloosa		Greenville	Virginia
Walker	North Carolina	Kershaw	Amherst
Wilcox	Anson	Lancaster	Bath
	Ashe	Laurens	Craig
Arkansas	Burke	Lexington	Franklin
Baxter	Caldwell	Newberry	Henry
Carroll	Catawba	Pickens	Mecklinburg
Clark	Cherokee	Richland	Rockbridge
Cleburne	Clay	Union	Surry
Franklin	Cleveland	York	
Garland	Davidson		West Virginia
Marion	Forsyth	Tennessee	Berkeley
Pike	Gaston	Blount	Grant
Yell	Graham	Campbell	Jefferson
	Halifax	Carter	Kanawha
Florida	Henderson	Clay	Monongalia
Jackson	Irodoll	Davidson	Putnam
	Jackson	De Kalb	
Georgia	Lincoln	Dickson	
Baldwin	McDowell	Greene	
Bartow	Macon	Hamilton	
Clay	Madison	Hardin	
Columbia	Montgomery	Humphreys	
Dougherty	Polk	Jefferson	
Fannin	Stanley	Loudon	
Forsyth	Stokes	Marion	
Fulton	Swain	Meigs	
Habusham	Washington	Moore	
Harris		Polk	
Hart	Oklahoma	Sevier	
Jasper	Cherokee	Smith	
Murray	Haskell	Sullivan	
Muscogee	McCurtain	Warren	

APPENDIX G. ELECTRICITY EXPORTS IN THE SOUTH IN 1975

(10⁶ x kwh)

Alabama	19,167
39.5% to Georgia	
27.7% to Tennessee	
21.6% to Mississippi	
11.2% to Florida	
Arkansas	7,789
36.4% to Mississippi	
23.5% to Tennessee	
19.1% to Oklahoma	
13.7% to Louisiana	
7.3% to other states	
Florida	3,871
52.4% to Alabama	
47.6% to Georgia	
Georgia	2,012
48.2% to Tennessee	
41.5% to Alabama	
5.6% to South Carolina	
4.7% to Florida	
Kentucky	18,818
55.9% to Tennessee	
21.1% to Indiana	
20.3% to Ohio	
1.9% to Virginia	
.8% to Illinois	
Louisiana	7,232
52.8% to Mississippi	
37.0% to Arkansas	
10.2% to Texas	

Mississippi	2,543
64.1% to Alabama	
19.3% to Louisiana	
12.5% to Arkansas	
4.1% to Tennessee	
North Carolina	9,677
41.5% to South Carolina	
31.5% to Virginia	
26.3% to Tennessee	
.7% to Georgia	
Oklahoma	9,629
52.8% to Arkansas	
30.6% to Kansas	
12.2% to Texas	
4.4% to Missouri	
South Carolina	5,832
63.2% to North Carolina	
36.8% to Georgia	
Tennessee	10,872
34.3% to Kentucky	
21.3% to Alabama	
15.5% to Arkansas	
14.1% to Mississippi	
10.7% to Georgia	
4.1% to other states	
Texas	6,094
62.4% to Louisiana	
15.2% to Oklahoma	
10.0% to Arkansas	
9.4% to New Mexico	
2.9% to Mexico	
Virginia	9,837
48.2% to North Carolina	
34.4% to Maryland	
16.6% to Tennessee	
.8% to West Virginia	

APPENDIX H

ALABAMA

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Alabama is a moderate-size state in the South with 6% of the region's population. In terms of its energy production and resources, its comparative advantage is in coal. As Table I illustrates, however, the state also has relatively substantial natural gas and NGL reserves remaining. Most of this natural gas was discovered during the last five years, distinguishing the state from both the region and the nation.

Table I. Energy production and reserves in Alabama in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Crude oil	78	354	4.5
Natural gas	41	843	20.4
NGL	26	1,014	38.7
Coal	583	76,752	131.7
Hydropower	42	77	1.8
Nuclear	29	215	7.5
Total	799	79,255	99.2

With 13 counties engaged in hydro generation of electricity, the state has 19% of the hydro capacity in the region. TVA has one nuclear facility (Brown's Ferry) operating in Decatur, and a second facility is scheduled for commercial operation in Scottsboro (Bellefonte plant) in 1981. The Alabama Power Company has a facility scheduled for operation in Dothan in 1979. The Barton facility, which was to have been constructed in Clanton, has been postponed indefinitely.

Per capita income in Alabama is 9% less than the regional average, and the state has 21% fewer mean heating degree days than the average southern state. These statistics suggest that the state is a small user of energy. In per capita terms, however, Alabama is the 11th largest energy user in the nation.

The state is most dependent upon coal, its most abundant resource. Table II illustrates the per capita energy usage in the state in 1974 and Table III relates this pattern of energy usage with that in the nation as a whole. The largest per capita energy use in Alabama is by the electric utilities, which use more energy per capita than other states. The residential and commercial sectors use 31% less energy per capita than is typically the case. Overall, the state uses 21% more energy per capita than the national average.

Given its high rate of energy consumption, it is not surprising that Alabama is a net importer of over half its total energy needs. The

Table II. Per capita energy use in Alabama in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	0.20	19.55	25.85			45.59
Industrial	64.81	8.73	47.72			121.26
Electric utilities	102.97	1.26	1.45	26.41	18.74	150.83
Transportation		90.43	5.51			95.94
Other		1.59				1.59
Total	167.97	121.57	80.53	26.41	18.74	415.22

Table III. Ratio of 1974 per capita energy use in Alabama

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	0.14	0.68	0.73			0.69
Industrial	3.32	0.31	1.01			1.28
Electric utilities	2.55	0.08	0.09	1.69	3.27	1.59
Transportation		1.08	1.70			1.10
Other		1.37				1.37
Total	2.74	0.77	0.78	1.69	3.27	1.21

bulk of these imports are crude oil and natural gas liquids which are processed and used primarily by the transportation sector. A major oil pipeline links Knoxville and Chattanooga with the Birmingham area, then extends to the Louisiana Gulf Coast.

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. There are ten counties in the state which produce either oil or natural gas. Production first began in 1904, but the first year of recorded production was in 1953. The annual depletion rate of its gas reserves has been less in Alabama than in the region or the nation. Consequently, whereas the United States retains only 30% of its proven recoverable reserves, Alabama has 87% of its natural gas reserves remaining.

Approximately 37% of its proven reserves of gas were discovered in 1975. To determine the amount of gas remaining, we should add to proved reserves the extensions and revisions likely to be forthcoming during the next twenty-five years, Alabama could have over 50 years of natural gas, even at 1976 production rates. This is contingent on whether the state is able to continue to import natural gas from Mississippi to satisfy 91% of its natural gas needs. The two major pipelines serving the state are Southern Natural Gas Company and Transcontinental Gas Pipe Line Corporation. Table IV shows the interstate pipeline receipts and shipments of natural gas in 1975.

Table IV. Interstate shipments of natural gas in Alabama in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	37.8
Receipts	2711.9
100.0% from Mississippi	
Shipments	2471.7
46.0% to Georgia	
44.3% to Tennessee	
9.7% to Florida	
Retained for consumption	278.0
Consumption	264.8
Δ Underground storage	-0.1

Crude Oil. Alabama is a net exporter of crude oil, the fossil fuel being the second most important mineral product of the state in terms of value. Approximately 4.2 million acres are under lease by oil companies for exploration (13% of the total land area). Average annual

production has tripled over the past twenty-five years (see Figure 1), however, and only 23% of the remaining recoverable reserves are still available.

The annual depletion rate is over twice as great as that of the region and the nation. Since new discoveries have not offset the increased production, the reserve/production ratio has fallen three times as fast as that of the United States. Even adding probable indicated and inferred reserves to the proven reserve base, it is likely the state will deplete its oil reserves by 1990. Current interstate receipts and shipments are shown in Table V below.

Table V. Interstate shipments of crude oil in Alabama in 1975

	Amount (bbl $\times 10^3$)
Production	13,477
Receipts	11,518
50.4% from Florida	
43.8% from Mississippi	
5.8% from foreign sources	
Shipments	11,628
85.5% to Louisiana	
7.5% to Kentucky & Tennessee	
7.0% to Georgia	
Net Shipments	110
Retained for consumption	13,367
Δ Stocks	113
Refinery loss	85
Crude runs to stills	13,169

Between 1972 and 1975 Alabama began to rely on foreign sources of crude oil. Approximately 95% of all interstate shipments are via pipeline, 4% by tanker, and only 1% by truck. All crude truck lines (5% of the total mileage) are located in the southern portion of the state to maximize the efficiency of using both pipelines and tankers for oil transport to the refineries in Mobile and Tuscaloosa counties. The bulk of crude oil receipts are from PAD I and Mississippi; the bulk of shipments to Ohio and Illinois.

Fig. 1. Alabama Oil Production.

Coal. There are 136 active coal mines in 12 counties in the northern portion of the state. Coal is the most valuable mineral product of the state. Alabama, with 130 years of coal remaining, produced over twice as much coal per capita as the nation as a whole.

Despite its large share of production, however, the state is a net importer of coal. Table VI shows the production, shipments, and receipts of coal in 1975, when Alabama imported 20% of its coal requirements. Most of this coal is imported from Kentucky and shipped to electric utilities. In 1975 Alabama imported 36,700 tons of coal from Australia. The gross exports of coal are to Georgia and Florida, and Japan. Approximately 60% of all coal shipments are by rail, 28% by truck, and 12% by barge.

Table VI. Shipments of bituminous coal in Alabama in 1975
(tons $\times 10^6$)

Total production	22,644
Shipments	20,101
Rail, 60.0%	
Truck, 27.7%	
Water, 12.3%	
Nonmarketed production	2,543
Mine-mouth facilities, 79.6%	
Other, 20.4%	
Receipts	28,205
Electric utilities, 68.2%	
Coke and gas plants, 24.0%	
Retail dealers, 0.1%	
Other, 7.7%	

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. There is one asphalt plant in Tuscaloosa with a production capacity of 1500 barrels per stream day (Warrior Asphalt Corporation). The two major refineries, Hunt Oil and the Marion Corporation, have a capacity of 50,000 barrels per stream day. The state has catalytic reforming and hydro-treating facilities to enhance the production of the lighter petroleum products, such as gasoline and distillates. There are five major product lines in the state, representing 1458 pipeline miles, each passing through Tuscaloosa, the refining center, and into Georgia.

There are now three natural gas processing plants in the state with a total capacity of 37.5 million cubic feet per day. The largest of these is owned by Phillips Petroleum Company and is located in Washington County. Placid Oil also has a small plant in Choctaw County and Cities Service Company has a plant in Mobile County. Together these plants produced about 1.3 billion barrels of LPG, propane, and natural gasoline in 1975.

Electricity. The state of Alabama generates 69% more electricity per capita than the nation as a whole, most of it by conventional steam from coal-fired plants. There were 16 fossil fuel plants in 1975 with 68% of the total generating capacity, 20 hydro plants with 17% of the capacity, and 1 nuclear plant with 15% of the capacity. The reliance of the state upon hydro and nuclear generation exceeds that of the region and the nation. Internal combustion generation is not employed. Approximately half of the generation capacity is investor-owned.

THE DEMAND FOR ENERGY

Before examining the demand for energy by individual sector and fuel type, a summary of the fuel mix of each sector and its total BTU usage is presented in Table VII. Over 40% of Alabama's energy requirements are met by coal, 29% by oil, 19% by natural gas, and 11% by hydro and nuclear power. Both the utilities and industrial sector are most reliant upon coal, and are the state's largest energy users. The residential-commercial sector is primarily dependent upon natural gas.

Table VII. Fuel mix by sector in Alabama in 1974
(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	0.4	42.9	56.7			163.0
Industrial	53.4	7.2	39.4			433.5
Electric utilities	68.3	0.8	1.0	17.5	12.4	539.2
Transportation		94.3	5.7			343.0
Total	40.4	29.3	19.4	6.4	4.5	1484.3

The heavy reliance upon coal is unusual with respect both to the region and the nation. Moreover, it is typically the industrial sector which uses the bulk of the energy in a state, rather than the utilities sector. The residential-commercial sector uses less coal than is typical of that sector. The industrial sector, however, uses 2.5 times as much coal as would be anticipated based on national averages. Total per capita energy imports are four times as great as is typical of the United States.

ENERGY USAGE BY SECTOR

Residential. Like many southern states, Alabama has more mobile homes than the nation as a whole and is more reliant upon LPG for space and water heating. It also has few multiple unit homes, and 20% more

single-family housing units than the national average. Electricity is the primary fuel for cooking and water heating, and natural gas the primary fuel for space heating. Table VIII indicates the actual fuel usage of the sector relative to both the region and the nation. Also shown are the equivalent Btu fuel prices and how they compare with the rest of the United States.

Table VIII. Fuel use by the residential sector in Alabama in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	0.78	0.26	2.68	1.04
Natural gas	1.00	0.63	1.54	0.92
Electricity	1.09	1.40	7.37	0.78
Kerosene	0.44	0.70	3.01	1.04

Per capita electricity usage is seen to be abnormally high with respect to the nation, and 9% higher than the regional average. All other fuels, however, are underutilized on a per capita basis. Electricity is the most expensive fuel, but is 22% cheaper in Alabama than elsewhere. Natural gas prices are 8% below the national average, while distillate oil and kerosene cost 4% more on the average.

Commercial. Approximately 60% of the total employment in the state is in commercial activities. Alabama has a slightly higher mix of government employees than the region, but overall has fewer commercial employees. The fuel usage of this sector is shown in Table IX which indicates the fuel mix, equivalent Btu fuel prices, and fuel usage per employee.

Table IX. Fuel use by the commercial sector in Alabama in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	0.7	0.17			1.0	0.17
Oil	43.9	1.13	2.68	1.04	64.9	1.13
Natural gas	33.5	0.96	1.05	0.80	49.5	0.96
Electricity	21.9	0.98	8.31	0.90	32.4	0.98

The sector is most dependent upon petroleum products, but natural gas is also an important fuel. Natural gas prices are 20% lower on the average and electricity prices 10% lower than elsewhere in the nation.

On a per employee basis, natural gas and electricity usage in Alabama is similar to that in other states. The usage of coal, however, is lower than is typical. Since 1972 there has been some shifting away from natural gas toward electricity by the sector. This, no doubt, has been in response to the increased uncertainty associated with natural gas availability and anticipated curtailments. As noted, 90% of the natural gas requirements of the state are met by imports.

Manufacturing. About 37% of the state's total employment is in the industrial sector, of which 81% are engaged in manufacturing activities. The energy usage by fuel of each two-digit SIC in Alabama in 1974 was examined to determine possible underlying bases of the energy consumption patterns exhibited by this sector. As shown in Table X, per employee oil usage is especially high in the chemicals and stone-clay-glass industries, with average per employee oil usage 34% higher than in other states. The furniture, paper, chemicals, and rubber-plastics industries are large coal users. The average electricity usage per employee is 88% higher in Alabama than other states. Overall energy usage per employee is 38% higher. Food manufacturing requires 48% less energy per worker than is typical, but the paper and chemical and instruments industries all use substantially more energy per worker than the national average.

Table X. Energy-intensiveness indices of manufacturing in Alabama in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.16	0.00	0.56	0.87	0.52
22	0.25	0.52	1.41	1.38	1.04
23	0.13	0.20	1.62	0.98	1.02
24	0.38	0.04	1.21	0.86	0.82
25	0.65	2.76	0.97	1.23	0.85
26	1.54	3.74	3.07	1.98	2.36
27	1.36	0.00	0.46	1.18	1.00
28	2.58	2.43	1.43	2.58	1.81
30	0.54	2.35	2.43	1.84	1.74
32	2.69	0.59	1.73	1.53	1.71
33	0.68	0.47	0.69	1.61	0.97
34	0.16	0.00	0.80	0.85	1.01
35	0.03	0.00	1.42	1.36	1.12
36	0.20	0.00	1.42	1.40	1.36
37	0.46	0.00	0.80	0.74	0.68
38	0.00	0.00	54.86	1.06	8.65
39	0.13	0.00	0.55	0.59	0.62
Average	1.34	1.70	1.17	1.88	1.38

Table XI indicates the fuel mix of the manufacturing sector in Alabama, the equivalent Btu fuel prices, and fuel usage per employee. The sector is seen to be primarily reliant upon natural gas, indicating that the non-manufacturing industries are most dependent on coal. In terms of overall fuel mix, Alabama uses coal and electricity in manufacturing to a greater extent than other states. All fuel prices paid by the sector are relatively lower, particularly the prices of coke, coal, and electricity. Based on average expenditures for all energy sources, however, the statistics indicate the cost of fuel was approximately equivalent. The statistics on average energy use per manufacturing employee vary slightly from those in Table X given the different sources of employment data, but basically tell the same story: Alabama manufacturing requires more energy per capita, especially coal and electricity, than is the case in other states.

Table XI. Fuel use by the manufacturing sector in Alabama in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	11.5	1.23	0.74	0.86	30.3	1.65
Oil	12.6	0.97	1.71	0.90	33.1	1.30
Gas	41.7	0.85	0.62	0.94	109.6	1.14
Electricity	21.4	1.36	3.39	0.84	56.3	1.83
Coke	5.4	1.90	0.99	0.65	14.2	0.04
Total	92.6		1.44	0.99	262.7	1.34

Electric Utilities. The fuel usage patterns of the utility sector are shown in Table XII. The statistics for 1975 indicate an unusually heavy reliance upon coal and hydro power for electrical generation. This is certainly an asset given the national energy policies now being formulated in Congress. There will be fewer plants to convert away from oil and gas in Alabama than elsewhere. The prices paid for coal, oil, and gas by the sector are slightly higher than those paid elsewhere in the nation. Natural gas prices were 74% higher in 1975 and coal prices 12% higher. Given the reliance upon hydro sources, however, the overall cost of generating a kilowatt hour of electricity was 9% less in Alabama than the national average.

Transportation Facilities. Most of the major highways and railroads have a north-south orientation, and are adequate to handle the transportation of fossil energy raw materials and by-products. If coal production should increase significantly in Alabama, however, additional rail spur lines would be required. Access to the Gulf Coast is provided at Mobile.

Table XII. Fuel use by the electric utility sector in Alabama in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	71.2	1.60	0.97	1.12	10,914	2.71
Oil	0.5	0.03	2.10	1.05	74	0.05
Gas	0.9	0.06	1.30	1.74	135	0.10
Hydro	22.5	1.44			3,457	2.44
Nuclear	4.9	0.55			751	0.92
Total	100.0		0.98	0.91	15,331	1.69

APPENDIX I
ARKANSAS

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Arkansas is the second smallest state in the South with only 3% of the region's population. In terms of its energy production and resources, its comparative advantage is in natural gas. As Table I illustrates, the state also has relatively substantial coal reserves remaining.

Table I. Energy production and reserves in Arkansas
in 1975 (Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Crude oil	94	555	5.9
Natural gas	127	2,179	17.2
Natural gas liquids	3	16	5.0
Coal	14	19,146	1,364.1
Hydropower	12	32	2.7
Nuclear	51	83	1.6
Total	301	22,011	73.2

With nine counties engaged in hydro generation of electricity, the state has 8% of the hydro capacity in the region. Arkansas Power & Light has one nuclear facility now in operation in Russellville, with a second unit scheduled to begin operation in January 1978.

Per capital income in Arkansas is 13% less than the regional average, but the state has 18% more mean heating degree days than the average southern state. The statistics suggest that Arkansas is an average per capita user of energy. Relative to other states, however, its energy usage has increased since 1972, its rank increasing from 14th to 13th in the nation as a per capita user.

Table II indicates the per capita energy usage in the state in 1974 by fuel and by sector. Table III relates this pattern of energy usage with that in the nation as a whole. The largest per capita energy user is the transportation sector, which is the most reliant upon petroleum products. Overall, the state depends largely upon crude oil and natural gas for meeting its energy requirements. Per capita natural gas usage is 41% higher than the national average. The electric utilities use 32% less energy per capita than is typical, while the transportation sector uses 15% more energy than the average.

Arkansas is a net importer of approximately two-thirds of its energy needs. The bulk of these imports are crude oil and natural gas liquids which are processed and used primarily by the transportation sector. The state has four petroleum refineries and two natural gas processing plants.

Table II. Per capita energy use in Arkansas in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		30.75	37.09			67.84
Industrial	1.40	13.40	82.11			96.91
Electric utilities		20.79	19.34	22.68	1.84	64.65
Transportation		93.57	6.67			100.24
Other		3.05				3.05
Total	1.40	161.56	145.21	22.68	1.84	332.69

Table III. Ratio of 1974 per capita energy use in Arkansas

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		1.07	1.04			1.03
Industrial	0.07	0.48	1.73			1.02
Electric utilities		1.26	1.16	1.45	0.32	0.68
Transportation		1.12	2.06			1.15
Other		2.63				2.63
Total	0.02	1.02	1.41	1.45	0.32	0.97

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. There are 19 counties in the state which produce either oil or natural gas. Production first began in 1889, peaked in 1970, and has been sharply declining since. To provide a better picture, Figure 1 charts the production trend of the state. A little over 35% of the proven recoverable reserves of gas remain. The annual depletion rate has been increasing over time, but is currently less than that of the region or the nation as a whole. Very few new discoveries of natural gas have occurred during the last five years. By adding the extensions and revisions likely to be forthcoming during the next twenty-five years and adequate price incentives, Arkansas should have about 25 years of natural gas remaining (assuming 1976 production rates continue). This is contingent, of course, on whether the state is able to continue to satisfy over half its natural gas needs with imports from Louisiana and Texas. Table IV shows the interstate receipts and shipments of natural gas in 1975. The major interstate pipeline companies serving the state are Mississippi River Transmission Corporation, Natural Gas Pipeline Company of America, and Texas Eastern Transmission Corp.

Table IV. Interstate shipments of natural gas
in Arkansas in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	116.2
Receipts	2362.7
72.4% from Louisiana	
22.3% from Texas	
5.3% from Oklahoma	
Shipments	2215.4
67.8% to Mississippi	
32.2% to Missouri	
Retained for consumption	263.5
Consumption	259.1
Δ Underground storage	+0.3

Crude Oil. Arkansas is a net importer of crude oil, despite the fact that oil is the principal mineral product in the state. In 1975 Arkansas met approximately 18% of its oil needs with imports from Texas and Louisiana. Production first began in 1921, peaked in 1925, was fairly constant during the 1950's, and has since declined (see Figure 2). The annual depletion rate has declined approximately 40%. Currently, this depletion rate is only half as great as that of the region and the nation as a whole. Only 6% of the recoverable reserve base remains, the reserve/production ratio having fallen to half its 1950 level. Even adding

Fig. 1. Arkansas Gas Production.

Fig. 2. Arkansas Oil Production.

probable indicated and inferred reserves to the proven reserve base, it is likely the state will deplete its oil reserves by 1991. Current interstate receipts and shipments are shown in Table V.

Table V. Interstate shipments of crude oil
in Arkansas in 1975

	Amount (bbl $\times 10^3$)
Production	16,133
Receipts	5,908
86.2% from Texas	
13.8% from Louisiana	
Shipments	2,515
70.7% to Illinois	
29.3% to Kansas	
Retained for consumption	19,526
Δ stocks	-13
Refinery loss	2
Crude runs to stills	19,211

Approximately 99% of the interstate shipments are via pipeline, as are 95% of the intrastate shipments. The remaining shipments are sent via truck, and there are no foreign shipments. Of the total pipeline mileage in the state (1449 miles), 72% is product line mileage, 24% is crude truck line mileage, and 4% is crude gathering line mileage. Mobil Oil owns the major truck line, which emanates in Texas and passes through Oklahoma and the northwestern portion of Arkansas. Approximately 23% of the land area is either productive of oil and gas or is currently under exploration lease.

Coal. There are seven active coal mines in Arkansas located in the northwestern corner of the state in four counties. Coal is not a major mineral product of the state, and there is relatively little coal produced. There are, however, considerable reserves of bituminous, lignite, and anthracite remaining given the current production level. Table VI shows the coal shipments of the state in 1975. The bulk of these shipments were by rail to utilities in Kansas.

THE SUPPLY OF ENERGY: ENERGY OUTPUTS

Petroleum Products. There were four operating refineries in the state in 1975, with a total capacity of 62.4 thousand barrels of crude per stream day. The largest of these is in El Dorado and is owned by the Lion Oil

Company. The other refineries are located in Smackover, Stephens, and Norphlet. Each plant produces not only gasoline and distillate oils, but asphalt as well. There are seven major product lines.

Table VI. Shipments of bituminous coal
in Arkansas in 1975
(tons $\times 10^6$)

Total production	488
Shipments	473
Rail, 86.3%	
Truck, 13.1%	
Water, 0.6%	
Nonmarketed production	16
Mine-mouth facilities, 0.0%	
Other, 100.0%	
Receipts	34
Electric utilities, 0.0%	
Coke and gas plants, 0.0%	
Retail dealers, 0.0%	
Other, 100.0%	

There were two gas processing plants in the state in 1975: the Hamilton plant of Arkansas-Louisiana Gas Company in Columbia County and the McKamie plant of Phillips Petroleum Company in Lafayette County. These two plants had a total capacity of 138 million cubic feet of gas per day and produced 1.2 million barrels of NGL, propane, natural gasoline, etc., in 1975.

Electricity. In 1975 there were 11 hydro plants, 23 fossil fuel plants, and 1 nuclear plant in Arkansas. Approximately 71% of the total generation capacity is investor-owned. In 1975 approximately 57% of the capacity was from conventional steam, 23% from hydro sources, 19% from nuclear sources, and 1% from internal combustion. About half of the fossil fuel generation is from gas-fired plants and the other half from oil-fired plants. This represents some shift away from gas-fired plants since 1972. The state has no coal-fired facilities at this time. The conversion mandate of the National Energy Plan could, therefore, have substantial effect on this sector in Arkansas.

THE DEMAND FOR ENERGY

Before examining the demand for energy by individual sector and fuel type, a summary of the fuel mix of each sector and its total Btu usage is presented in Table VII. Over 48% of Arkansas' energy requirements are met by petroleum products, 44% by natural gas, 7% by hydro sources, and only

1% by coal and nuclear sources. The residential-commercial and industrial sectors are most reliant upon natural gas, the utilities upon hydro, and the transportation sector upon petroleum products.

Table VII. Fuel mix by sector in Arkansas
in 1974 (Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential- Commercial	0.0	45.3	54.7			140.3
Industrial	1.4	13.8	84.7			200.4
Electric Utilities	0.0	32.2	29.9	35.1	2.8	133.7
Transportation		93.3	6.7			207.3
Total	0.4	48.5	43.7	6.8	0.6	688.1

In terms of total Btu consumption of energy, it is the industrial and transportation sector which use most of the state's energy. This is similar to the pattern observed in the region as a whole, though the utilities play a much less important role in Arkansas in determining total energy consumption. In 1972 Arkansas did not consume any coal, but by 1975 several industries had begun utilizing coal as a resource. Undoubtedly, the role of coal in Arkansas' energy future will continue to grow. Total per capita energy imports are almost four times as great as is typical of the United States.

ENERGY USAGE BY SECTOR

Residential. Arkansas has more mobile homes and more single-family housing units than the nation as a whole. Natural gas is the primary fuel used for space and water heating as well as cooking. Electricity usage by the sector is less than typical of the region but 11% higher than the national average. Table VIII indicates the actual fuel usage of the sector relative to both the region and nation, the equivalent Btu fuel prices, and how they compare with the rest of the United States.

Both kerosene and LPG usage are higher in Arkansas than the rest of the nation but less than the regional average. Distillate oil is underutilized with respect to both the region and the nation. While natural gas usage appears high with respect to the region, it is about equivalent with the national average for the sector. Natural gas prices paid by this sector are 35% lower, electricity prices 9% lower, and distillate oil prices 8% lower than those paid elsewhere in the United States.

Table VIII. Fuel use of the residential sector in Arkansas in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	0.66	0.22	2.38	0.92
Natural gas	1.58	1.99	1.09	0.65
Electricity	0.85	1.09	8.56	0.91
Kerosene	0.77	1.23	2.77	0.95

It is to be noted that Arkansas is somewhat atypical of the West South Central region in its heavier reliance upon space heating as a primary end use, and natural gas as a primary fuel. The census of 1970 indicates less than average fuel usage for appliances such as dishwashers, freezers, etc.

Commercial. Over 60% of the employees in Arkansas are engaged in commercial activities. The commercial sector is primarily reliant upon petroleum and natural gas. Table IX indicates per employee fuel usage, equivalent Btu fuel prices paid, the relative fuel mix of the sector, and the relationship to the nation. Per employee natural gas usage by this sector is 78% higher than the national average, per employee oil usage is 67% higher, and per employee electricity usage is 20% higher. All prices paid by the sector were lower than those prevailing elsewhere in the nation. Natural gas prices were 34% lower and electricity prices 14% lower.

Table IX. Fuel use of the commercial sector in Arkansas in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Petroleum	42.5	1.09	2.38	0.92	96.2	1.67
Natural gas	40.2	1.16	0.87	0.66	91.1	1.78
Electricity	17.3	0.78	7.95	0.86	39.3	1.20

Manufacturing. Industrial employment in Arkansas is 38% of the total, 18% higher than the national average. Approximately 82% of these employees are engaged in manufacturing activities. Table X provides energy-intensiveness indices of each 2-digit SIC in the state in 1974. The paper and chemicals industries are seen to be very heavy oil users, the chemicals industry using four times as much energy per employee than the national average. The majority of the manufacturing industries use high per employee quantities of natural gas, such that the average for the sector is twice

that of the nation. Per employee electricity usage is roughly comparable, though the manufacturing of primary metals in Arkansas now requires three times the amount of electricity required elsewhere by this industry. Overall, the manufacturing sector of Arkansas uses 45% more energy per worker than the national average.

Table X. Energy-intensiveness indices of manufacturing in Arkansas in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.06		1.08	1.08	0.80
22	0.19		3.22	0.92	1.34
23	0.00		0.63	0.92	0.46
24	0.42		2.34	0.93	1.97
25	0.00		1.59	1.14	0.93
26	2.42		3.47	1.27	2.17
27	0.00		1.09	1.07	1.18
28	4.36		6.48	0.78	4.15
29	1.12		0.64	0.12	0.64
30	0.06		1.73	1.06	0.89
31	0.02		0.62	0.80	0.50
32	0.39		3.13	0.01	1.93
33	0.13		2.21	3.09	1.65
34	0.08		0.66	0.79	0.65
35	0.00		0.82	0.98	0.60
36	0.00		1.08	0.93	0.88
37	0.00		0.75	1.02	0.95
38	0.00		0.74	0.32	0.27
39	0.00		0.00	1.93	0.59
Average	1.27		1.97	1.09	1.45

Table XI indicates the fuel mix, equivalent Btu fuel prices, and fuel usage per employee of this sector in 1974. The sector is primarily reliant upon natural gas, 36% more so than manufacturing sectors in other states. Natural gas prices are 26% less than the national average and fuel oil prices 12% less. Overall fuel prices are 22% lower in Arkansas. Electricity prices and per employee usage are similar to the national average for the manufacturing sector.

Table XI. Fuel use of the manufacturing sector in Arkansas in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal						
Oil	11.4	0.88	1.68	0.88	32.0	1.26
Gas	66.7	1.36	0.49	0.74	187.7	1.95
Electricity	11.8	0.75	4.27	1.05	33.1	1.07
Coke						
Total	89.9		1.13	0.78	281.2	1.43

Since 1971 the manufacturing of textiles and paper products became somewhat less energy intensive, though both industries still use more energy per worker than the national average. This was also true of the chemicals industry, the state's largest industrial energy user.

Electric Utilities. As of 1975 the utilities sector of Arkansas became primarily dependent upon nuclear energy. In 1972 the primary utility fuel was natural gas, which has now taken second place to both hydro and nuclear power as an electrical generation power source. The heavy reliance upon nuclear energy is 4 times the national average. Natural gas prices are 19% lower for the sector, but the cost of generating a kilowatt hour of electricity is 9% higher than the U.S. average. On a per capita basis, the state uses 3 times as much nuclear energy as is typical but generates 28% less electricity per capita. Table XII summarizes these statistics on fuel mix, equivalent Btu fuel prices, and per capita energy use in the sector in 1975.

Table XII. Fuel use of the electric utility sector in Arkansas in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	.0					
Oil	19.3	1.28	1.93	0.96	1251	0.92
Gas	20.1	1.29	0.61	0.81	1304	0.93
Hydropower	25.0	1.60			1622	1.15
Nuclear	35.6	3.96			2305	2.86
Total	100.0		1.17	1.09	6482	0.72

APPENDIX J

FLORIDA

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Rapid population growth in Florida has been associated with increasing demands for energy, particularly petroleum and natural gas. In terms of its energy production and resources, Florida's comparative advantage is in crude oil. As Table I illustrates, however, the state has only five years of energy remaining from its proven domestic resources.

Table I. Energy production and reserves in Florida in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Crude oil	242.9	1523	6.3
Natural gas	48.5	292	6.0
NGL	28.6	184	6.5
Hydropower	0.8	1	1.1
Nuclear	89.3	142	1.6
Total	410.1	2138	5.2

Hydro generation of electricity is located in only two counties, and accounts for a very small proportion of the total energy supply. There is one nuclear facility in Florida City (Turkey Point) in operation. The Florida Power Corporation is scheduled to begin commercial operation of the Crystal River plant in Red Level during 1977. Florida Power and Light has the St. Lucie facility scheduled for completion in 1982. Jacksonville is the proposed site of the new manufacture, assembly, and preoperational testing of eight floating nuclear facilities to be implemented in 1982.

Florida is the second largest state in the region with per capita income 10% higher than the regional average. There are 78% fewer heating degree days. Given its abundance of sunshine, the state is the smallest per capita energy user in the nation (excepting Hawaii). Table II illustrates the per capita energy usage in the state in 1974 by fuel and sector. Table III relates this pattern of energy usage with that in the nation as a whole.

Petroleum satisfies 71% of the energy needs of Florida, the bulk of oil usage occurring in the transportation sector. Both the utilities and the transportation sectors are high energy users relative to the residential, commercial, and industrial sectors. Relative to the nation as a whole, however, all fossil fuels are relatively underutilized. The utilities use about three times as much oil per capita as is typical and almost twice as much nuclear power. Overall the state uses 35% less energy per capita than other states. Despite its relatively small demand for energy, the state is forced to import 84% of its fuel needs.

Table II. Per capita energy use in Florida in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		12.97	4.70			17.67
Industrial		9.04	11.98			21.02
Electric utilities	17.69	52.17	19.42	0.33	10.37	99.99
Transportation		84.79	0.38			85.17
Other		0.38				0.38
Total	17.69	159.34	36.50	0.33	10.37	224.24

Table III. Ratio of 1974 per capita energy use in Florida

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		0.45	0.13			0.27
Industrial		0.32	0.25			0.22
Electric utilities	0.44	3.17	1.17	0.02	1.81	1.06
Transportation		1.01	0.12			0.98
Other		0.33				0.33
Total	0.29	1.01	0.36	0.02	1.81	0.65

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. Five counties in the state produce either oil or gas. Production first began in 1943, but the first year of recorded production was in 1949. Average annual production has been increasing over time (Figure 1), and the current depletion rate is higher than that in the region or the nation. The bulk of the natural gas reserves were discovered between 1951 and 1971, with few new discoveries occurring during the last five years. Florida has 59% of its proven recoverable reserves remaining, but production from those reserves continues to outpace additions to reserves. By adding the extensions and revisions likely to be forthcoming during the next twenty-five years, given adequate price incentives, Florida can extend its domestic gas supply until 1989. This is contingent, of course, on there being no further increases in the annual rate of extraction, and continuing imports from Alabama to satisfy 85% of its natural gas needs. Natural gas is transported by three interstate pipelines, the largest of which is Florida Gas Transmission Company. Table IV shows the interstate shipments of natural gas in Florida in 1975.

Table IV. Interstate shipments of natural gas
in Florida in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	44.4
Receipts	246.6
Alabama, 97.0%	
Georgia, 3.0%	
Shipments	0.0
Retained for consumption	291.0
Consumption	289.3
Δ Underground storage	0.0

Crude Oil. Florida is a net exporter of crude oil, the second most important mineral product in the state. Approximately 10% of the total land area has proven productive or is currently under lease for exploration. Production began in 1943, remained relatively constant until 1970, and has since skyrocketed. Figure 2 charts the production trend in the state over time. The annual depletion rate is over three times that of the region or the nation. Approximately 56% of the proven recoverable reserves remain. Adding the probable indicated and inferred reserves to the proven reserve base, it is likely the state will deplete its oil reserves by 1990. It is currently relying upon foreign sources of oil for 98% of its crude petroleum. This dependence could hurt the state in the event of another embargo.

Fig. 1. Florida gas production.

Fig. 2. Florida oil production.

Table V indicates the interstate shipments of crude oil in Florida in 1975. Most oil is delivered via tanker to its three main ports: Tampa, Port Everglades, and Jacksonville. The state's only refinery is an asphalt plant in St. Marks (Seminole Asphalt). There is one crude trunk line (28 miles long) emanating from the Jay field in Santa Rosa and Escambia counties. There are no intrastate shipments of crude oil. There are only two petroleum product lines in Florida.

Table V. Interstate shipments of crude oil
in Florida in 1975

	Amount (bbl $\times 10^3$)
Production	41,877
Receipts	1,691
Foreign sources, 100%	
Shipments	41,577
Texas, 30.8%	
Louisiana, 28.4%	
Alabama, 14.0%	
Delaware and Maryland, 12.0%	
Kentucky and Tennessee, 7.3%	
Pennsylvania, 6.2%	
Indiana, 1.0%	
Illinois, 0.4%	
Retained for consumption	1,991
Δ Stocks	-35
Crude runs to stills	1,723

Coal. There is no coal produced in Florida, the state being primarily dependent upon coal shipments from Kentucky, Alabama, and Illinois. In 1975 there were also imports from South Africa, Canada, and Australia. The bulk of this foreign coal is shipped to Gulf Power Company for electrical generation.

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. The Seminole Asphalt Refining Company in Wakulla County has a capacity of 6,000 barrels of oil per stream day. Most of the petroleum is imported from domestic sources, though there are substantial foreign imports from Venezuela, the Netherlands Antilles, and the Bahamas. Three new refineries have been proposed in the state with a potential yearly production of 210 million barrels.

There are two natural gas processing plants with a combined capacity of 990 million cubic feet of gas per day. The Florida Hydrocarbons Company has the Brooker plant in Bradford County, and Exxon has the Jay plant in Santa Rosa County. In 1975 these plants produced 12.8 billion barrels of propane, ethane, butane, and natural gasoline.

Electricity. In 1975 there were 2 hydro plants, 89 fossil fuel plants, and 1 nuclear plant generating electricity. Five different hydro-electric facilities have been operated in Florida, the largest being Southeastern Power Administration's 30 megawatt facility at the Jim Woodruff dam. About 82% of all capacity is investor-owned. Conventional steam generation accounts for 92% of the total, most of these plants being oil-fired. Nuclear generation accounts for an additional 7% of capacity, and hydro for less than 1%. The heavy reliance upon oil for generation is almost 4 times the national average. The conversion mandate of the National Energy Plan could impose severe burdens on Florida utilities in the 1980's.

Though there are uranium oxide deposits in the state, no uranium is being produced. The zirconium-clad uranium oxide needed by the nuclear plant is currently being supplied by Westinghouse Corporation and is shipped from South Carolina by truck.

THE DEMAND FOR ENERGY

Before examining the demand for energy by individual sector and fuel type, a summary of the fuel mix and total Btu usage is presented in Table VI.

Table VI. Florida energy consumption by fuel: 1960-1974

Fuel	1960		1970		1974	
	Mix (%)	10 ¹² BTUs	Mix (%)	10 ¹² BTUs	Mix (%)	10 ¹² BTUs
Gasoline	32.1	238.3	27.2	409.3	28.9	525.5
Residual oil	24.5	182.1	23.1	346.8	26.2	474.3
Distillate oil	10.4	77.5	7.7	115.9	7.5	135.1
LPG	2.7	19.8	2.1	31.4	1.6	29.6
Jct. fuel	2.1	15.4	6.3	94.7	4.7	86.6
Non-energy	3.9	28.8	2.5	36.9	2.2	39.4
Petroleum	75.7	561.9	68.9	1035.0	71.1	1290.5
Natural gas	19.4	144.5	23.1	347.4	16.3	295.6
Coal	4.8	36.0	7.9	119.5	7.9	143.3
Hydropower	0.1	1.0	0.1	0.9	0.1	2.7
Nuclear	0.0	0.0	0.0	0.0	4.6	84.0
Total	100.0	743.4	100.0	1502.8	100.0	1816.0

Over 71% of Florida's energy requirements are met by petroleum, which is the primary fuel of all sectors except the industrial sector, which is a relatively insignificant energy user. Total per capita energy imports are 3.6 times as great as the national average.

Residential. Florida has an unusually large number of mobile homes and is very reliant upon LPG. Electricity is the prime fuel for cooling. There has been a dramatic expansion in electricity utilization by all sectors in the state, most notably, however, by the residential sector. Unlike the rest of the South, Florida uses relatively little natural gas. Table VII indicates the fuel usage in Florida relative to both the region and the nation, as well as the equivalent Btu fuel prices paid by the sector. Per capita electricity usage is seen to be 51% greater than the national average, while per capita oil usage is 76% lower and natural gas usage 92% lower.

Table VII. Fuel use by the residential sector in Florida in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	0.71	0.24	2.74	1.06
Natural gas	0.13	0.08	2.68	1.60
Electricity	1.17	1.51	10.00	1.06
Kerosene	0.25	0.40	3.08	1.06

One reason for the lack of reliance upon natural gas may be problems of availability. Not inconsequential, however, is the fact that residential users of Florida pay 60% more for natural gas than do other states. Electricity prices, by contrast, are only 6% higher than the national average.

Not too surprisingly, the state uses considerable quantities of electricity for air conditioning--almost 3 times as much as other states in the nation. Energy usage for refrigeration is also somewhat higher than elsewhere in the United States.

Commercial. Almost 75% of the state's employees are engaged in commercial activities (15% more than the national average). Retail trade and finance-insurance-real estate employment are especially high. Table VIII shows the fuel mix of the sector, the equivalent Btu fuel prices, and the per employee fuel usage in 1975. The sector was most reliant upon electricity, as was the residential sector. This dependence is over twice as great as is typical of the sector in other states. Natural gas prices were 26% higher, electricity prices 14% higher, and fuel oil prices 6% higher than elsewhere in the nation. On a per employee basis, fuel usage of oil was 75% less than in other states, fuel usage of gas was 69% less, but fuel usage of electricity was 14% higher than the average.

Table VIII. Fuel use by the commercial sector in Florida in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	0.0					
Oil	21.0	0.54	2.74	1.06	14.2	0.25
Gas	23.5	0.68	1.66	1.26	15.9	0.31
Electricity	55.5	2.49	10.58	1.14	37.6	1.14

Industrial. Only 23% of the state's employment is in the industrial sector. Of these employees, 57% are engaged in manufacturing activities. Table IX shows energy-intensiveness indices for the two-digit SICs in Florida in 1974. The paper and chemicals industries both use over four times as much oil per employee than the national average. Only the paper industry consumed more than the average amount of natural gas per employee. The leather industry used over 6 times as much electricity per worker as the national average. Overall per capita energy usage was relatively highest for the paper and leather industries. For all industries, energy usage per capita was 22% lower than the national average.

Table IX. Energy-intensiveness indices of manufacturing in Florida in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	2.56		0.69	1.12	0.97
21	2.00		0.43	0.81	0.29
22	2.02		0.18	0.33	0.19
23	2.00		0.30	0.73	0.65
24	2.38		0.21	0.48	0.49
25	2.04		0.00	0.74	0.29
26	4.26		1.07	0.33	1.89
27	0.23		0.12	1.25	0.54
28	4.14		0.81	1.12	1.08
29	1.75		0.03	2.58	0.21
30	0.01		0.15	0.99	0.34
31	0.00		0.00	6.28	1.31
32	2.32		0.32	0.66	0.56
33	0.00		0.44	0.43	0.35
34	0.12		0.31	1.04	0.56
35	0.01		0.12	0.65	0.35
37	1.12		0.16	0.79	0.46
38	0.04		0.00	1.57	0.39
39	0.00		0.35	1.68	0.81
Average	0.90		0.48	0.69	0.78

Table X shows the fuel mix of the manufacturing sector, the equivalent Btu fuel prices paid, and the fuel usage per employee in 1974 in Florida. The sector was most reliant upon fuel oil--over 3.5 times as reliant as the average manufacturing sector. Fuel oil prices were 15% lower, while natural gas prices were 15% higher and electricity prices 36% higher. The overall average fuel price was 27% higher in Florida than elsewhere.

Table X. Fuel use by the manufacturing sector in Florida in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal						
Oil	45.6	3.52	1.63	0.85	71.3	2.81
Gas	30.1	0.61	0.77	1.15	47.0	0.49
Electricity	14.0	0.89	5.52	1.36	21.9	0.71
Coke						
Total	89.7		1.85	1.27	156.4	0.80

Electric Utilities. The utilities were most reliant upon petroleum (Table XI), and again this heavy reliance is atypical of utilities elsewhere in the nation. Fuel oil prices paid by the sector were 7% lower, natural gas prices 6% lower, but coal prices 17% higher than those prevailing in other states. The average cost of generating a kilowatt hour of electricity was 38% higher than the national average. On a per capita basis, again it is oil that appears to be most over-utilized. 62% less coal was used for electrical generation than in other states. The second largest producer of electricity in the region, per capita energy usage by the sector was 4% higher than the national average.

Table XI. Fuel use by the electric utility sector in Florida in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	16.1	0.36	1.01	1.17	1504	0.38
Oil	56.5	3.75	1.87	0.93	5261	3.88
Gas	16.3	1.04	0.71	0.94	1519	1.08
Hydropower	0.3	0.02			28	0.02
Nuclear	10.8	1.20			1002	1.24
Total	100.0		1.49	1.38	9314	1.04

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APPENDIX K
GEORGIA

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Georgia is the fifth largest state in the South, with 8% of the region's population. As Table I illustrates, the state produces no crude oil, natural gas, or natural gas liquids. The largest energy source available within the state is nuclear power, but per capita generation of nuclear electricity is less than the national average.

Table I. Energy production and reserves in Georgia in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Coal	1.7	11.8	7.1
Hydropower	14.6	37.5	2.6
Nuclear	35.1	0.0	0.0
Total	51.4	49.3	1.0

Nineteen counties in the state have hydro generation facilities. Georgia Power Company operates the Edwin Hatch facility in Baxley, and has scheduled the Vogtle plant for commercial operation in 1984 in Waynesboro.

Per capita income is 1% less than the regional average and there are 18% fewer mean heating degree days. In terms of its per capita energy consumption, the state is ranked 35th in the nation, as it was in 1972. Table II examines energy utilization patterns of each sector and Table III compares these patterns with those of the nation as a whole.

The state is most reliant upon petroleum for satisfying its energy requirements, the transportation sector being the largest petroleum and total energy user. The residential-commercial sector relies primarily upon natural gas, as does the industrial sector, while the electric utilities are most reliant upon coal-fired facilities for electrical generation. Per capita energy usage of each fuel is less in Georgia than elsewhere in the United States, per capita natural gas usage being 32% less than the national average. The industrial sector uses only half the amount of energy per capita as is typical. Overall, the state uses 24% less energy per capita than other states.

THE SUPPLY OF ENERGY: Energy Inputs

Hydrocarbons. There are no oil or gas wells in Georgia, and there has never been any hydrocarbon production in the state. Table IV indicates the interstate shipments of natural gas in Georgia in 1975. As was true in 1972, the state receives all its natural gas from Alabama, and a substantial portion of this gas is then shipped to South Carolina via the pipeline between Columbia, South Carolina, and Columbus, Georgia.

Table II. Per capita energy use in Georgia
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	0.23	15.17	25.24			40.62
Industrial	1.56	12.24	34.94			48.74
Electric utilities	50.50	10.21	9.08	7.40	0.10	77.30
Transportation		93.11	1.03			94.14
Other		1.15				1.15
Total	52.29	131.88	70.29	7.40	0.10	261.96

Table III. Ratio of 1974 per capita energy use in Georgia

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	0.16	0.53	0.71			0.62
Industrial	0.08	0.44	0.74			0.51
Electric utilities	1.25	0.62	0.55	0.47	0.02	0.82
Transportation		1.11	0.32			1.08
Other		0.99				0.99
Total	0.85	0.83	0.68	0.47	0.02	0.76

Table IV. Interstate shipments of natural gas in Georgia in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	0.0
Receipts	1137.4
Alabama, 100.0%	
Shipments	809.1
South Carolina, 97.3%	
Tennessee, 1.8%	
Florida, 0.9%	
Retained for consumption	328.3
Consumption	326.6
Δ Underground storage	+0.3

Table V illustrates the interstate shipments of crude oil in the state in 1975. Approximately 85% of the crude oil processed by the state's two refineries is imported from foreign sources. The remainder is shipped by truck (or barge) from Alabama and Louisiana. There are no crude gathering or crude trunk lines in Georgia.

Table V. Interstate shipments of crude oil in Georgia in 1975

	Thousands of barrels
Receipts	5,373
Foreign sources, 84.9%	
Alabama, 15.1%	
Shipments	0
Retained for consumption	5,373
Change in stocks	-110
Crude runs to stills	5470

Coal. There are three active coal mines in Chattooga and Dade counties. Most of the coal needed for electrical generation, however, is imported from Kentucky by rail. Table VI illustrates the shipments of bituminous coal in 1975.

Table VI. Shipments of bituminous coal
in Georgia in 1975
(tons $\times 10^6$)

Total production	0
Shipments	74
Rail, 77.0%	
Truck, 17.6%	
Water, 5.4%	
Nonmarketed production	0
Receipts	15,018
Electric utilities, 97.4%	
Coke and gas plants, 0.0%	
Retail dealers, 0.2%	
Others, 2.4%	

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. Amoco Oil Company has a refinery in Chattam and Young Refining Corporation has a refinery in Douglasville, Georgia. These two refineries have a capacity of 19.4 thousand barrels per stream day, with a production capacity for asphalt of 11.6 thousand barrels per day. Three product lines enter Georgia, two passing through Tennessee, and two through South Carolina for a total of 1,874 pipeline miles.

There are no natural gas processing plants in the state at this time. There are three major natural gas distributors in Georgia: Southern Natural Gas Company, Transcontinental Gas Pipe Line Corporation, and South Georgia Natural Gas Company.

Electricity. There are 30 hydro plants and 24 fossil fuel plants in the state, accounting for 10% and 90%, respectively, of the generation capacity. Approximately 93% of the total generation capacity is investor-owned. The reliance upon coal-fired facilities is much higher in Georgia than the rest of the South. The conversion mandate of the National Energy Plan, then, will have relatively little impact on the utilities in Georgia.

THE DEMAND FOR ENERGY

Before examining the demand for energy by individual sector and fuel type, a summary of the fuel mix of each sector and its total Btu consumption is presented in Table VII. There is considerable variation in fuel mix between the sectors. Over 62% of the energy needs of the residential-commercial sector are met by natural gas, which also accounts for 72% of the energy used by the industrial sector. The utilities, however, use natural gas for only 12% of the total electrical generation. Overall, the

Table VII. Fuel mix by sector in Georgia in 1974
(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	0.5	37.4	62.1			198.1
Industrial	3.2	25.1	71.7			237.7
Electric utilities	65.3	13.2	11.8	9.6	0.1	377.0
Transportation		98.9	1.1			459.1
Total	20.0	50.4	26.8	2.8	0.0	1277.6

state meets approximately half its energy needs from petroleum, 27% from natural gas, and 20% from coal. The state has 5 times the amount of per capita energy imports as the nation as a whole.

Residential. Unlike other states in the South, Georgia does not have an unusually large number of mobile homes. The state has more air conditioners and freezers per household than do other states in the nation. Despite the heavy reliance upon natural gas, it is the sector's use of electricity for space and water heating and cooling which is atypical relative to the United States. The per capita fuel usage, equivalent Btu fuel prices, and how they relate to residential sectors in other states in the South and in the nation is shown in Table VIII.

Table VIII. Fuel use by the residential sector
in Georgia in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	0.52	0.17	2.54	0.98
Natural gas	1.22	0.77	1.47	0.88
Electricity	0.94	1.21	8.25	0.88
Kerosene	0.12	0.19	3.04	1.04

Natural gas usage per capita appears high relative to the region (Table IX), but is 23% less than the national average. Electricity is the most expensive fuel in Georgia (as elsewhere), but is 12% cheaper in the state than in other states. Natural gas prices are also 12% lower, though fuel oil prices are approximately the same. Despite the relatively lower prices, fuel oil usage per capita is less in Georgia than elsewhere.

Table IX. Fuel use by the commercial sector in Georgia in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	0.8	0.21			1.0	0.17
Oil	30.3	0.78	2.54	0.98	36.1	0.63
Natural gas	38.8	1.12	1.07	0.97	46.3	0.90
Electricity	30.1	1.35	9.97	1.25	35.9	1.09

Commercial. Approximately 63% of the state's employees are engaged in commercial activity. Natural gas is the primary fuel, but again it is the dependence upon electricity which is atypical with respect to the nation. Oil and gas prices are slightly lower in Georgia than in other states, though not significantly so. Calculations of fuel usage per employee indicate that natural gas, petroleum, and coal are relatively underutilized by the sector, particularly coal. Electricity usage per commercial employee, however, is 9% higher than the national average.

Manufacturing. Approximately 33% of the employment in the state is in the industrial sector, 82% of which is concentrated in manufacturing. Table X shows energy-intensiveness indices of manufacturing by two-digit SIC in Georgia in 1974. The paper industry uses twice as much oil per employee as is typical, such that the manufacturing sector in Georgia on average uses 20% more oil than the national average. Only in the apparels industry is coal usage per worker unusually high (over 5 times the national average). Natural gas usage per employee is high in several manufacturing industries, but the average indicates that 28% less natural gas is used than would be expected given the employment. Similarly, electricity usage per worker is less than typical. Overall, the manufacturing sector of Georgia uses 19% less energy per worker than do manufacturing sectors in other states.

Table XI indicates the fuel mix of this sector, the equivalent Btu fuel prices paid, and the fuel usage per employee. Most dependent upon natural gas, the sector is atypically reliant upon petroleum. Coal prices are 31% higher than the national average, and overall fuel prices paid by the sector are 12% higher in Georgia than elsewhere. On a per employee basis, fuel usage of oil is 20% higher than average, but overall energy usage less.

Electric Utilities. The utility sector, as previously noted, is primarily dependent upon coal (Table XII), 53% more so than utilities in other states. Both oil and gas-fired plants are relatively underutilized. Coal prices paid by the sector are 19% higher, while oil and gas prices are slightly less. The average cost of generating a kilowatt hour of electricity in Georgia is about the same as in other states. On a per capita basis, it is again coal which is relatively over-utilized. The utilities in Georgia generate 6% less electricity per capita than is typical.

Table X. Energy-intensiveness indices of manufacturing in Georgia in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.39	0.00	0.75	1.01	0.67
22	0.62	0.73	1.87	1.17	1.24
23	0.56	5.41	1.95	1.13	0.94
24	0.52	0.00	1.00	0.74	0.76
25	0.37	0.00	0.67	0.82	0.89
26	2.06	0.87	1.33	1.19	1.52
27	0.08	0.00	0.69	1.14	0.99
28	0.82	0.18	0.67	0.99	0.82
29	0.27	0.00	0.29	0.16	0.27
30	0.34	0.00	1.51	1.16	0.87
32	0.47	0.50	0.00	1.03	0.96
33	0.24	0.00	0.44	0.46	0.39
34	0.14	0.00	0.53	1.06	0.70
35	0.12	0.00	18.44	0.79	0.76
36	0.35	0.00	1.97	1.43	1.35
37	0.29	0.01	1.46	1.06	0.99
39	0.03	0.00	0.59	0.89	0.67
Average	1.20	0.47	0.72	0.87	0.81

Table XI. Fuel use by the manufacturing sector in Georgia in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	5.4	0.58	1.14	1.31	8.6	0.47
Oil	19.2	1.48	1.60	0.84	30.4	1.20
Gas	43.7	0.89	0.74	1.10	69.1	0.72
Electricity	16.9	1.07	4.63	1.14	26.7	0.87
Coke	0.2	0.05	2.31	1.51	0.2	0.00
Total	85.4		1.63	1.12	158.0	0.81

Table XII. Fuel use by the electric utility sector in Georgia in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	68.0	1.53	1.03	1.19	5759	1.44
Oil	6.4	0.42	1.95	0.97	538	0.40
Gas	7.9	0.51	0.71	0.95	673	0.48
Hydropower	10.3	0.66			868	0.62
Nuclear	7.4	0.83			628	0.78
Total	100.0		1.06	0.99	8467	0.94

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APPENDIX L
KENTUCKY

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Kentucky, with 5% of the region's population, is the second largest coal producer in the South. Table I illustrates the production and proved reserves of energy in Kentucky in 1975.

Table I. Energy production and reserves in Kentucky in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Crude oil	44	228	5.2
Natural gas	66	888	13.4
Natural gas liquids	12	172	13.8
Coal	3,563	633,713	177.8
Hydropower	12	20	1.7
Total	3,697	635,021	171.8

Four counties in the state are engaged in the hydro generation of electricity, but currently there are no nuclear facilities. There are no nuclear plants under construction in the state at this time either.

Per capita income is 7% less than the regional average, but the state has 54% more heating degree days. In terms of its per capita Btu energy usage, it is ranked 27th in the nation. Table II indicates the per capita energy consumption in the state by sector and by fuel in 1974. Table III relates these energy utilization patterns of those in the nation as a whole.

The electric utilities are the largest energy consuming sector in the state, accounting for 43% of the total energy consumption. They are most reliant upon coal-fired plants for electrical generation. The industrial sector of the state is most reliant upon coal, though the residential-commercial sector is more dependant upon natural gas. Coal usage overall in Kentucky is 2.7 times as great as in the nation as a whole. All other fuels are relatively underutilized by comparison. The state, on average, uses approximately the same amount of energy per capita as do other states in the United States.

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. Over half of the counties in the state (64) have oil or gas production. Gas production first began in 1888, but is not a major mineral product of the state. Approximately 14% of the land area has proven productive or is under exploration lease. Figure 1 illustrates the production trend of natural gas since 1935 has been rather unstable.

Table II. Per capita energy use in Kentucky in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	2.03	16.79	36.05			54.86
Industrial	26.33	8.05	24.78			59.15
Electric utilities	138.01	0.51	1.67	9.51		149.70
Transportation		76.71	8.94			85.66
Other		0.45				0.45
Total	166.37	102.50	71.44	9.51		349.82

Table III. Ratio of 1974 per capita energy use in Kentucky

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	1.44	0.58	1.01			0.83
Industrial	1.35	0.29	0.52			0.62
Electric utilities	3.42	0.03	0.10	0.61		1.58
Transportation		0.91	2.76			0.98
Other		0.39				0.39
Total	2.72	0.65	0.69	0.61		1.02

Fig. 1. Kentucky gas production.

Production peaked in 1947, but has basically declined since 1967. The bulk of the reserves were discovered prior to 1950, and very few new discoveries have occurred during the last five years.

The average annual depletion rate is less than that of the region or the nation, but Kentucky has only about 20% of its proven recoverable reserves of gas remaining. The reserve/production ratio has been declining over the past twenty-five years. By adding to the estimate of proved reserves the extensions and revisions likely to be forthcoming during the next three decades, it appears that Kentucky will have natural gas available until 2000. This, of course, is contingent upon the continued imports from Tennessee which satisfied approximately 81% of the natural gas needs of the state in 1975. Another determining factor is whether or not Kentucky can maintain its current rate of production.

Table IV indicates the interstate shipments of natural gas in Kentucky in 1975. Shipments of natural gas are primarily to Ohio and Indiana. This pattern of receipts and distribution has not changed significantly since 1972. Several parallel gas lines connect northwestern Kentucky with Nashville and the gas fields of Louisiana and Eastern Texas. The major interstate pipelines are those of Columbia Gulf Transmission Company, Tennessee Gas Pipeline Company, Texas Eastern Transmission Corporation, and Michigan Wisconsin Pipe Line Company.

Table IV. Interstate shipments of natural gas in Kentucky in 1975

	Amount ($\text{+t}^3 \times 10^9$)
Marketed production	60.5
Receipts	3684.5
Tennessee, 100.0%	
Shipments	3512.8
Ohio, 34.6%	
Indiana, 32.8%	
West Virginia, 21.9%	
Illinois, 10.6%	
Retained for consumption	232.2
Consumption	213.0
Δ Underground storage	+12.0

Crude Oil. Kentucky is a net importer of crude oil, with 37% of its crude oil needs being met by foreign imports. Production initially began in 1860, though the first recorded year of production was not until 1883.

The production trend of the state is charted in Figure 2. Production peaked in 1959 and has been declining almost consistently ever since (as is true of the reserve/production ratio). The annual depletion rate is less than that of the region or nation, but even so the state retains only 6% of its proven recoverable reserves. If we add probable indicated reserves, as well as those extensions and revisions likely to occur over the next twenty-five years, it appears the state could have oil domestically available until 1990. As with the case of natural gas, this is contingent upon continued imports of crude oil. In 1975 these imports satisfied 88% of the oil requirements of the state's refineries.

Table V indicates the interstate shipments of crude oil in the state in 1975. The pipeline is utilized for 66% of the interstate shipments while the other 34% of shipments are via barge. Marine transportation of energy is available via the Ohio and Mississippi Rivers. Approximately 70% of the intrastate shipments of oil are via pipeline, while 99% of the foreign shipments are via pipeline. The latter statistic arises from the fact that Kentucky is an inland state without port facilities for super tankers.

Table V. Interstate shipments of crude oil in Kentucky in 1975

	Amount (bbl $\times 10^3$)
Production	7,556
Receipts	52,379
Louisiana, 39.3%	
Foreign sources, 37.5%	
Illinois, Indiana, and Michigan, 15.4%	
PAD I, 5.8%	
Wyoming, 1.8%	
Ohio, 0.2%	
Shipments	3,359
West Virginia, 100.0%	
Retained for consumption	56,576
Δ Stocks	-62
Refinery loss	62
Crude runs to stills	55,634

Coal. There are 1,789 active coal mines in the state which produce Kentucky's most valuable mineral product — rich Appalachian coal. The state is a net exporter, most of the coal going to utilities in Tennessee, Georgia, and North Carolina via rail (refer to Table VI). On a per capita basis, the state produces about 14 times as much coal as is true

Fig. 2. Kentucky oil production.

Table VI. Shipments of bituminous coal in Kentucky in 1975
(tons $\times 10^6$)

Total production	143,613
Shipments	134,502
Rail, 74.8%	
Truck, 8.5%	
Water, 16.7%	
Nonmarketed production	9,111
Mine-mouth facilities, 95.7%	
Other, 4.3%	
Receipts	28,480
Electric utilities, 90.3%	
Coke and gas plants, 4.4%	
Retail dealers, 0.6%	
Other, 4.7%	

elsewhere in the nation. In 1975 there were 45 coal-producing counties in Kentucky.

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. There were three petroleum refineries in Kentucky in 1975: (1) Ashland Petroleum Company in Catlettsburg, the largest refinery, (2) Louisville Refining (division of Ashland Oil, Incorporated) in Jefferson county, and (3) Somerset Refinery, Incorporated in Pulaski county. These three refineries had a capacity of 169.5 thousand barrels of crude oil per stream day in 1975. Products are transported from Texas and Arkansas to Kentucky via the one product pipeline in the state.

There are two natural gas processing plants in the state, Kentucky Hydrocarbon in Floyd County and Tennessee Gas Pipeline Company in Greene County. These two plants had a capacity of 895 million cubic feet of gas per day in 1975 and produced 6.8 billion barrels of ethane and other NGL products.

Electricity. In 1975 there were 6 hydro plants and 27 fossil-fuel plants generating electricity in Kentucky. Approximately 43% of the total generating capacity was investor-owned. Of the total generation, 94% was from conventional steam-fired plants and 6% from hydro plants. As previously noted, the utilities are most reliant upon coal-fired plants. The conversion mandate of the National Energy Plan should not impose undue hardship, then, on the electric utilities in Kentucky.

THE DEMAND FOR ENERGY

Kentucky is currently exporting 63% of its total energy production to other states. What about its own demand for energy? Before examining the energy demand of each individual sector by fuel type, a summary of the fuel mix of each sector is presented in Table VII.

Table VII. Fuel mix by sector in Kentucky in 1974
(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	3.7	30.6	65.7			184.0
Industrial	44.5	13.6	41.9			198.4
Electric utilities	92.2	0.3	1.1	6.4		502.1
Transportation		89.6	10.4			287.3
Total	47.6	29.3	20.4	2.7	0.0	1173.3

The largest energy users, the electric utilities, are most reliant upon coal, the state's most abundant resource. Coal currently supplies 48% of the state's total energy requirements, petroleum supplies 29%, and natural gas 20%. At the national level, coal supplies only 18% of total energy requirements, petroleum supplies 46%, and natural gas 30%. The statistics thus indicate that Kentucky is somewhat unique in that it is slightly ahead of its time in shifting away from our relatively scarce hydrocarbons toward coal.

Residential. Kentucky has a relatively large number of two-unit and mobile homes. The use of coal for space heating is almost five times as great as that for other states. The primary fuel for water heating is natural gas, while electricity is the predominant fuel for cooking. Table VIII presents the fuel usage of the sector relative to the region and the nation, as well as the equivalent Btu fuel prices paid by the sector.

Relative to the region, Kentucky's residents use a lot of natural gas, but relatively little fuel oil and electricity. Relative to the nation, however, the state's use of natural gas is about average and electricity usage only 8% higher than typical. Natural gas prices are approximately 28% less and electricity prices 24% less than those prevailing in other states. Fuel oil prices are slightly higher. Most of the states in the East South Central region are most reliant upon electricity, so Kentucky is somewhat unique in its primary dependence upon natural gas.

Table VIII. Fuel use by the residential sector in Kentucky in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	0.71	0.24	2.69	1.04
Natural gas	1.61	1.01	1.20	0.72
Electricity	0.84	1.08	7.16	0.76
Kerosene	1.11	1.78	3.00	1.03

Commercial. Approximately 61% of the state's employees are engaged in commercial activities. Employment in finance, insurance, and real estate activities is low relative to the region. Table IX presents the fuel mix of this sector, the equivalent Btu fuel prices paid, and the fuel use per commercial employee in 1975. The energy consumption patterns are then compared with those of the nation as a whole.

Table IX. Fuel use by the commercial sector in Kentucky in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	6.5	1.61			10.7	1.79
Oil	22.4	0.57	2.69	1.04	36.6	0.64
Gas	37.7	1.09	1.04	0.79	61.7	1.20
Electricity	33.4	1.50	4.86	0.53	54.7	1.66

The sector is primarily reliant upon natural gas, but relative to the nation as a whole, all fuels are overutilized except oil. Fuel oil usage per employee is 36% less than the national average, prevailing in commercial sectors in other states, while electricity usage per employee is 66% greater, coal usage 79% greater, and natural gas usage 20% greater. Electricity prices paid by the sector are 47% less than in other states, and natural gas prices are 21% less.

Manufacturing. About 36% of the employment of the state is in the industrial sector, and 75% of this employment is concentrated in manufacturing activities. Table X presents energy-intensiveness indices of each 2-digit SIC in the state in 1974. Printers use 54% more oil per employee than is typical, but overall this sector uses 71% less oil than is typical of manufacturing in other states. Coal usage is twice as great, with the exceptionally heavy users being the apparel and primary metals industries. Overall natural gas usage per employee is 22% less than average, though several specific industries use more natural gas

Table X. Energy-intensiveness indices of manufacturing in Kentucky in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.72	1.74	2.03	0.79	1.07
21	0.43	0.07	2.91	1.07	0.98
22	0.01	1.33	0.96	1.03	0.72
23	0.23	6.42	1.47	0.70	0.80
24	0.39	1.67	0.62	0.59	0.70
25	0.87	3.29	0.94	0.78	1.25
26	0.04	0.00	1.72	1.08	0.72
27	1.54	0.00	1.74	1.13	0.94
28	0.33	3.42	0.51	9.13	2.09
29	0.42	0.00	0.00	3.53	0.98
30	0.76	0.00	2.04	1.48	1.38
31	0.05	0.00	0.00	0.57	0.56
32	1.03	0.77	1.03	1.31	1.06
33	0.19	5.09	0.98	3.44	2.25
34	0.24	4.56	1.32	0.86	1.19
35	0.31	4.16	0.82	1.39	1.29
36	0.29	4.39	1.59	1.82	1.88
37	0.14	1.30	1.86	1.26	1.31
38	0.00	0.00	3.48	1.12	0.63
39	0.00	0.00	1.46	0.89	0.56
Average	0.29	2.02	0.78	3.13	1.32

than would be expected. Electricity usage by the sector is three times as great as the national average, with the heaviest usage in the chemicals industry. Overall, the state's manufacturing sector uses 32% more energy per worker than the national average.

Table XI indicates the fuel mix of the sector, the equivalent Btu fuel prices paid, the fuel usage per employee. The sector is seen to be most reliant upon electricity, but is atypically reliant upon coke and coal as well. Electricity prices are 34% less than the national average and coal prices are 17% less. Overall fuel prices paid by the sector, however, are 14% higher than those prevailing in other states.

Table XI. Fuel use by the manufacturing sector in Kentucky in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	14.3	1.53	0.72	0.83	36.4	1.98
Oil	2.8	0.22	1.92	1.00	7.1	0.28
Gas	29.1	0.59	0.69	1.03	73.7	0.77
Electricity	37.2	2.37	2.69	0.66	94.4	3.06
Coke	12.8	4.48	1.54	1.00	32.4	0.08
Total	96.2		1.65	1.14	253.8	1.29

Electric Utilities. Table XII indicates the fuel mix of the utilities, the equivalent Btu fuel prices, and fuel usage per capita in 1975. The sector uses twice as much coal for electrical generation as is typical, underutilizing other fuels relative to the nation. All fuel prices paid are less in Kentucky than elsewhere. Coal is 20% cheaper, fuel oil is 16% cheaper, and natural gas is 69% cheaper. Overall, the cost of generating a kilowatt hour of electricity is 31% less in Kentucky than in most other states. Coal usage per capita by the sector is 3.5 times as great as the national average. Total electrical generation per capita is 67% greater in Kentucky than elsewhere in the United States. Given the low fuel prices and coal availability, it is unlikely that Kentucky will be forced to turn to nuclear generation in the near future.

Table XII. Fuel use by the electric utility sector in Kentucky in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	93.1	2.09	0.69	0.80	14,010	3.50
Oil	0.1	0.01	1.69	0.84	15	0.01
Gas	0.0		0.31	0.41	5	0.00
Hydropower	6.8	0.43			1,020	0.72
Nuclear	0.0					
Total	100.0		0.69	0.64	15,050	1.67

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APPENDIX M

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Approximately 29% of America's oil and gas supplies originate in Louisiana (which has only 6% of the region's population), or enter its pipelines from offshore wells in Federal waters. One of every ten jobs in the state is directly oil-related. About 45% of all state revenues comes from fees, taxes, and royalties on oil and gas production and refining. Table I illustrates the energy production and reserves in Louisiana in 1975.

Table I. Energy production and reserves in Louisiana in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Crude oil	3,775	22,198	5.9
Natural gas	7,750	67,011	8.6
Natural gas liquids	801	6,927	8.6
Total	12,326	96,136	7.8

There was no generation of electricity from hydro or nuclear sources in 1975 in the state. Louisiana Power and Light has the Waterford station scheduled for commercial operation in 1981 in Taft. Gulf States Utilities Company has the River Bend station in St. Francisville scheduled for completion in 1983. There are small lignite deposits in DeSoto Parish. Despite the state's lack of coal, hydro, and nuclear energy, it exports 73% of its total energy production.

Per capita income is 6% less than the regional average and the state has 41% fewer mean heating degree days. The state is the largest per capita energy user in the region, and is the second largest per capita energy user in the nation. Most of this usage is by the industrial sector, Louisiana being a large processor of energy as well as producer. Table II indicates the per capita fuel usage of each sector in 1974 and Table III relates this pattern of energy usage with that of the nation as a whole.

The striking characteristics of energy usage in Louisiana is that oil and gas supply all the state's energy needs. There is no coal usage nor any reliance upon hydro or nuclear sources. Natural gas supplies 77% of the total energy requirements. This rate of usage is five times that of the nation as a whole, with the average per capita energy usage in the state twice as large as the national average. The industrial sector uses over four times as much energy as is typical, while the residential-commercial sector uses 21% less energy than the average state.

Table II. Per capita energy use in Louisiana in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		11.48	40.70			52.18
Industrial		23.05	396.36			419.41
Electric utilities		15.10	96.47			111.56
Transportation		110.93	20.68			131.61
Other		2.71				2.71
Total		163.26	554.20			717.46

Table III. Ratio of 1974 per capita energy use in Louisiana in 1974

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		0.40	1.14			0.79
Industrial		0.82	8.36			4.41
Electric utilities		0.92	5.81			1.18
Transportation		1.32	6.38			1.51
Other		2.34				2.34
Total		1.03	5.39			2.09

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. Of the 64 parishes in the state, 61 have oil or gas wells. Approximately 32% of the total land area has been proven productive or is under exploration lease. Natural gas is the second most important mineral product in terms of value. Production began in 1905 and continually increased until 1973, the peak production year. Figure 1 charts the production trend of the state between 1935 and 1975. The average annual depletion rate has increased over time and now exceeds that of the region and the nation. Of its proven recoverable reserves of natural gas, only 31% remain. If we add the anticipated extensions and revisions likely to occur over the next twenty-five years, Louisiana should have natural gas until 1993. This figure is based upon the assumption that Louisiana will continue to export 71% of its natural gas production, that natural gas production will be maintained at its 1976 rate, and no new discoveries will be forthcoming. A change in any of these variables could extend the number of years of gas remaining.

Table IV indicates the interstate shipments of natural gas in Louisiana in 1975. All of the receipts of natural gas are from Texas, and the bulk of exports are to Mississippi (which then exports to other states in the Northeast). The natural gas pipeline network in the state is, of course, extensive.

Table IV. Interstate shipments of natural gas in Louisiana in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	7090.6
Receipts	847.0
Texas, 100.0%	
Shipments	5883.7
Mississippi, 70.9%	
Arkansas, 29.1%	
Retained for consumption	2053.9
Consumption	1978.1
Δ Storage	58.7

Crude Oil. Production of crude oil, the most important mineral product in the state, began in 1902, peaked in 1971, and has since declined. Figure 2 charts the production history of oil in the state since 1920. Average annual production rates have increased over time and the current average annual depletion rate exceeds that of the region or the nation. Of the total proven recoverable resource base, Louisiana retains only 19%. By adding the state's indicated reserves, and probable

Fig. 1. Louisiana gas production.

Fig. 2. Louisiana oil production.

extensions and revisions likely to occur over the next twenty-five years, it appears likely that the state will have reserves available until 1988. Again, this statistic is contingent on the maintenance of 1976 production levels, no new discoveries of oil, and the continued export of 17% of the state's production.

Table V indicates the interstate shipments of crude oil in the state in 1975. Almost half of the receipts of crude oil are from abroad, with the bulk of the shipments going to Texas, Illinois, Ohio, and Mississippi. All of the foreign shipments are by tanker, but only 8% of the interstate shipments are by tanker. Approximately 91% of the interstate shipments are by pipeline, as are 76% of the intrastate shipments. There are 8,160 miles of pipeline in Louisiana, 39% of which are crude truck lines, 31% product lines, and 30% crude gathering lines.

Table V. Interstate shipments of crude oil in Louisiana in 1975

	Amount (bbl $\times 10^3$)
Production	650,840
Receipts	111,039
Foreign sources, 80.3%	
Florida, 10.6%	
Alabama, 9.0%	
Oklahoma, .1%	
Shipments	222,243
Illinois, 25.0%	
Ohio, 23.3%	
Mississippi, 17.4%	
Kentucky & Tennessee, 10.7%	
Texas, 9.6%	
Indiana, 7.4%	
Michigan, 3.3%	
New York, 1.2%	
New Jersey, 1.0%	
Pennsylvania, .7%	
Arkansas, Del., Md., & Kansas, .5%	
Retained for consumption	539,636
Δ Stocks	2,112
Refinery loss	178
Crude runs to stills	549,790

Construction of the Louisiana Offshore Oil Port (LOOP) is scheduled to begin in 1978 and will be the nation's first deepwater port. By 1980 LOOP will unload 1.4 million barrels of imported oil a day, could attract \$2 billion in onshore investments, and create 16,000 new jobs. By 1989 LOOP will unload 3.4 million barrels of oil per day — 1.5 times the capacity of the Alaskan pipeline.

The \$1 billion facility will be offshore 19 miles south of Grand Isle, site of one of the state's sand beaches where the water is over 100 feet deep. Six buried pipes will radiate from the platform, running 8,150 feet out to special mooring buoys. Tankers up to 750,000 tons will be able to tie up to the buoys to discharge cargoes to the control platform. Onshore, the lines will follow Bayou Lafourche to St. James, where they will connect with an existing line carrying oil north to the Midwest.

A storage cavern will be created in a salt dome halfway to the St. James terminal. Injecting fresh water from surrounding canals and marshlands, engineers will leach 14 different cavities (with a storage capacity of 56 million barrels of oil) 1200 feet below the surface. Some brine will be used as a working fluid to flush out the stored oil. Excess brine will be held in a 200-acre above-ground reservoir.

When the venture was formed in 1972, there were seven participants. Several others joined then later dropped out, such that only five companies remain (Marathon, Texaco, Shell, Ashland, and Murphy Oil). There were numerous obstacles, not the least of which is the I.C.C. regulation on the return of investment limiting it to 7%. Each company has refineries in Louisiana that need assured supplies of crude oil.

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. There are 19 oil refineries in Louisiana with a capacity of 1.8 million barrels of crude oil per day. The state should attract many new refiners when the superport is completed. Louisiana is the second largest producer of gasoline and fuel oil in the South, and a net exporter of all refined products. The largest grass roots refinery in the nation (200,000 barrels per day) is now under construction in Garyville.

There are 112 natural gas processing plants in the state with a capacity of 22.6 billion cubic feet per day. In 1975 the state produced 228 billion barrels of raw NGL, propane, ethane, natural gasoline, and other products. On average these plants operated at 73% of capacity in 1975.

Electricity. All of the 59 plants in the state are fossil-fired, 98% gas-fired. Four major utilities (Middle South Utilities, Gulf States Utilities, Central Louisiana Electric Company, and Southwestern Electric Power Company), REA, and several municipally owned systems supply the state with electric power. Approximately 88% of the capacity

is investor-owned. The unusually heavy reliance upon natural gas is expected to impose severe burdens for utilities under the conversion mandate of the National Energy Plan.

THE DEMAND FOR ENERGY

Table VI presents the fuel mix of each sector in the state and its total Btu utilization in 1974. The industrial sector is, as previously noted, the largest energy user in the state. As are the electric utilities, the industries of Louisiana are primarily reliant upon natural gas. Overall, natural gas provides 77% of the total energy needs of the state.

Table VI. Fuel mix by sector in Louisiana in 1974

(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	0.0	22.0	78.0			196.3
Industrial	0.0	5.5	94.5			1577.8
Electric utilities	0.0	13.5	86.5	0.0	0.0	419.7
Transportation		84.3	15.7			495.1
Total	0.0	22.8	77.2	0.0	0.0	2699.1

Residential. Louisiana has very few multiple-unit homes relative to the nation as a whole. Natural gas is the primary fuel for space and water heating as well as cooking. Table VII indicates the fuel usage of this sector relative to the region and to the nation as well as the equivalent Btu fuel prices paid. Relative to the region, natural gas usage per capita is 75% higher, while fuel oil usage is 70% lower. Relative to the nation, the small usage of distillate oil is more striking — 90% lower than the U.S. average.

Per capita electricity usage is 20% higher than the national average and per capita natural gas usage 10% higher. Electricity prices are 23% less than the average, natural gas prices 20% less, and fuel oil prices 10% less. More importantly, the availability of natural gas to residents gives Louisiana a comparative advantage.

Commercial. Approximately 65% of the state's employees are engaged in commercial activity. Table VIII indicates the fuel mix of the sector, the equivalent Btu fuel prices paid, and fuel usage per commercial employee. The sector is primarily reliant upon natural gas, 34% more so

Table VII. Fuel use by the residential sector in Louisiana in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	0.30	0.10	2.32	0.90
Kerosene	1.39	2.22	3.29	1.13
Natural gas	1.75	1.10	1.34	0.80
Electricity	0.93	1.20	7.28	0.77

Table VIII. Fuel use by the commercial sector in Louisiana in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Petroleum	22.0	0.57	2.32	0.90	31.7	0.55
Natural gas	46.5	1.34	0.78	0.59	66.8	1.30
Electricity	31.5	1.41	6.46	0.70	45.3	1.38

than commercial sectors elsewhere in the nation. Natural gas prices are 41% less in Louisiana than other states, electricity prices 30% less, and fuel oil prices 10% less. On a per employee basis, natural gas usage is 30% higher than the national average and electricity usage is 38% higher.

Manufacturing. Only 28% of the state's employment is engaged in industrial activity, and only 57% of these employees are involved in manufacturing. It is not surprising, then, that the state is characterized by high energy/labor ratios. Table IX indicates energy-intensiveness indices for each two-digit SIC in Louisiana in 1974. The chemicals industry in the state uses over five times as much energy per worker as is typical. Petroleum refining and the manufacture of primary metals also requires unusually large amounts of energy relative to the number of employees.

Per employee fuel oil usage is over 3 times as great, and natural gas usage almost 10 times as great as the national average. There is no coal usage in the state, but per employee electricity usage is 3 times as great as the national average, particularly in the chemicals and refining industries. Overall, manufacturing in Louisiana requires 6 times as much energy per worker as manufacturing in other states, given the high mix of energy-intensive employment.

Table IX. Energy-intensiveness indices of manufacturing in Louisiana in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.06		2.69	1.05	1.77
22	0.00		0.00	0.53	0.55
23	0.08		1.83	1.32	1.32
24	0.37		2.01	0.97	0.99
26	1.51		4.30	1.93	2.27
27	0.00		0.47	0.93	0.51
28	0.54		8.05	2.92	5.28
29	7.42		2.10	2.64	2.37
32	0.54		3.01	0.99	1.74
33	0.10		9.41	0.59	4.10
34	0.04		0.68	0.85	0.83
35	0.05		0.30	0.77	0.87
36	0.06		1.35	1.41	1.04
37	0.01		0.25	0.49	0.31
39	0.00		4.26	0.94	1.62
Average	3.46		9.88	2.95	6.14

Table X indicates the fuel mix of the sector, the equivalent Btu fuel prices paid, and energy usage per worker in the sector in 1974. As noted, the sector is most reliant upon natural gas, 61% more so than manufacturing sectors in other states. Natural gas prices are 24% lower than elsewhere, electricity prices 23% lower, and fuel oil prices 19% lower. The average fuel cost in manufacturing in Louisiana is 45% less than the national average.

Electric Utilities. Table XI indicates the fuel mix of the utilities, the equivalent Btu fuel prices they pay, and energy usage per capita in Louisiana in 1974. The utilities are primarily reliant upon natural gas, for which they pay 17% less than the utilities in other states. The overall cost of generating a kilowatt hour of electricity is 31% lower than the national average. Per capita gas usage is 6 times the average, oil usage is 39% less than the average, and overall electrical generation 15% higher than the average.

Though there was no generation from hydro sources in 1975, hydro power from the Toledo Bend reservoir on the Sabine River is now supplying electricity (80 megawatts of capacity). One additional damsite exists at

Table X. Fuel use by the manufacturing sector in Louisiana in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal						
Oil	7.3	0.57	1.56	0.81	89.2	3.51
Gas	79.0	1.61	0.50	0.76	962.1	10.01
Electricity	7.6	0.48	3.10	0.77	92.1	2.99
Coke	0.0	0.01	2.05	1.33	0.2	0.00
Total	93.9		0.80	0.55	1217.7	6.21

Table XI. Fuel use by the electric utility sector in Louisiana in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Oil	8.3	0.55	1.94	0.97	859	0.63
Gas	91.7	5.86	0.62	0.83	9,488	6.75
Total	100.0		0.75	0.69	10,347	1.15

Bon Wier on the Sabine River, with a potential capacity of 20 megawatts. No other hydroelectric sites are likely to be developed in the state.

Gulf States Utilities has announced construction of two 540 megawatt coal units in the Lake Charles area for 1977-1978 and Central Louisiana Electric Company has announced a 550 megawatt coal unit for 1979. Both companies have contracted with Wyoming for low sulfur coal to be delivered in unit trains. Importation of eastern coal by barge on the Mississippi River may occur because of lower barge transport costs. The eastern coal, however, generally has objectionable high sulfur content requiring scrubbers. Since generation of electricity by coal will be a novelty for the state, it is important that low sulfur coal be burned to gain public acceptability.

ENVIRONMENTAL AND POLITICAL ISSUES

Louisiana has become a model in state regulation of mineral energy resources. The Department of Conservation completely monitors production and movement of oil and gas through the state. The Natural Resources and Energy Division has been created to adapt to changing energy conditions as well as exercise some limited control.

A primary concern of Louisiana has been settlement of the federal tidelands dispute. Judicial decisions have limited Louisiana to a three-mile offshore limit, as opposed to the three-leagues offshore limit of Texas and Florida. Final judicial decision is awaited on the exact location of the shoreline. The hope of the state for sharing in federal offshore revenue rests with legislative and administrative action at the federal level.

Another area of serious concern is the heavy reliance on severance taxes, royalty, and lease bonuses for a large part of the state's revenue. As production declines, the revenue base will be reduced. Tax rates have been increased, but there are limits to further increases. Louisiana is now placing the tax burden completely on in-state production, whereas an increasing amount of oil and gas is imported from adjacent states, federal offshore zones, and overseas for refining and processing.

The current trend toward coal as the fuel to fill the gap transfers to other sections of the nation the benefits which accrue to the supplier, a position Louisiana has enjoyed and become dependent upon. State-sponsored development of local resources for needed energy not only promotes the economic development of technological industries, but also provides an alternative to out-of-state energy sources.

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APPENDIX N
MISSISSIPPI

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Mississippi is a relatively small state with 4% of the region's population. Table I indicates the production and reserves of energy in the state in 1975. As was true of Louisiana, there is no coal production in Mississippi, nor any hydro or nuclear electrical generation facilities. Its current comparative advantage is in the production of crude oil. In terms of its remaining resources, however, the advantage is in natural gas. Mississippi Power and Light Company has the Grand Gulf nuclear station scheduled for commercial operation in Port Gibson in 1983.

Table I. Energy production and reserves in Mississippi in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Crude oil	270.4	1341	5.0
Natural gas	81.3	1320	16.2
Natural gas liquids	5.6	61	11.0
Total energy	357.3	2722	7.6

Per capita income in Mississippi is the lowest in the region--19% below the regional average. There are 21% fewer mean heating degree days. Its per capita energy consumption has declined somewhat since 1972. It is now ranked 22nd in the United States relative to a ranking of 19th in 1972. Table II indicates the fuel usage per capita of each sector in 1974. Table III relates these energy usage patterns with those of the nation as a whole.

The largest per capita energy user is the transportation sector, which uses an unusually large amount of natural gas for pipeline transport. The state is most reliant upon petroleum, particularly the electric utilities. The industrial sector is most reliant upon natural gas. As Table II indicates, most sectors are relatively small per capita energy users. Overall, the state uses 16% less energy per capita than the national average. Despite the low relative rates of consumption, however, the state imports almost three times as much energy per capita as is typical of other states.

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. In 1975 there were 42 counties producing either oil or gas, almost half the total. Approximately 24% of the total land area has proven productive or is currently under exploration lease. Natural gas is the second most important mineral product of the state. Production first began in 1923, peaked in 1962, and has been declining since 1964. The production history of the state is charted in Figure 1. The average

Table II. Per capita energy use in Mississippi in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		26.26	23.78			50.04
Industrial	0.51	11.40	59.81			71.72
Electric utilities	15.17	26.39	18.81			60.37
Transportation		81.83	22.02			103.86
Other		1.37				1.37
Total	15.72	147.26	124.42			287.40

Table III. Ratio of 1974 per capita energy use in Mississippi

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		0.91	0.67			0.76
Industrial	0.03	0.41	1.26			0.75
Electric utilities	0.38	1.60	1.13			0.64
Transportation		0.98	6.80			1.19
Other		1.18				1.18
Total	0.26	0.93	1.21			0.84

Fig. 1. Mississippi gas production.

annual depletion rate has declined over the past fifteen years as resources have been increasingly depleted. Today the state retains 18% of its proven recoverable resource base. Adding the probable extensions and revisions likely to occur over the next twenty-five years, it appears that Mississippi should have natural gas reserves until 1990. This is contingent upon continued imports from Louisiana and Arkansas to supply 70% of the demand requirements in the state, as well as a constant production rate similar to that of 1976.

Table IV indicates the interstate shipments of natural gas in Mississippi in 1975. A major feeder gas pipeline connects Jackson, Mississippi, with the Gulf Coast and eastern Texas gas fields. Should imported LNG become more important in the future to supplying the natural gas needs of the state, there are excellent port facilities at Biloxi and Gulfport.

Table IV. Interstate shipments of natural gas
in Mississippi in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	74.3
Receipts	5676.2
Louisiana, 73.5%	
Arkansas, 26.5%	
Shipments	5513.9
Tennessee, 50.8%	
Alabama, 49.2%	
Retained for consumption	236.6
Consumption	230.6
Δ Underground storage	-0.1

Crude Oil. Crude oil is the most important mineral product of the state. Production first began in 1889, though the first year of recorded production was not until 1926. Figure 2 charts the production history of oil in the state, indicating peak production in 1970, and the following decline. The average annual depletion rate has been declining over the past fifteen years, but currently exceeds that of the region or the nation. If no new discoveries are made, and production continues at current trends, the reserves/production rate indicates a depletion of proved reserves by 1982 (the state retains only 12% of its proven recoverable reserves). Adding the indicated reserves, and probable extensions and revisions of crude oil, Mississippi could extend its reserves of oil until 1986. This, of course, is contingent upon the continued ability of the state to import 58% of its crude oil requirements. Half of this imported oil is from abroad and thus subject to considerable political uncertainty.

Fig. 2. Mississippi oil production.

Table V indicates the interstate shipments of crude oil in the state in 1975. All interstate shipments are via pipeline, as are 89% of all intrastate shipments. Mississippi has 3,093 miles of crude oil and product pipelines, 52% of which are crude trunk or gathering lines. All foreign receipts of crude are via tanker.

Table V. Interstate shipments of crude oil
in Mississippi in 1975

	Amount (bbl $\times 10^3$)
Production	46,614
Receipts	77,266
Louisiana, 50.0%	
Foreign sources, 50.0%	
Shipments	19,856
Texas, 49.4%	
Alabama, 25.4%	
Ohio, 13.7%	
Penn., Ill., N.J., & Mich., 11.5%	
Retained for consumption	104,024
Δ Stocks	236
Crude runs to stills	98,253

Electricity. Virtually all of the state is divided into land areas certified by the Mississippi Public Service Commission. There are no hydro or nuclear facilities within the state, but utilities operate 25 fossil fuel plants, most of which are oil-fired. Approximately 91% of the total generating capacity is investor-owned. All capacity is in conventional steam generation, and none in internal combustion. Per capita electrical generation is 46% less than the national average.

THE DEMAND FOR ENERGY

Prior to presenting the demand for energy by individual sector and fuel, Table VI summarizes the fuel mix and total Btu usage of each consuming sector. The smallest per capita energy user in the state is the residential-commercial sector, which is primarily reliant upon natural gas and petroleum. Overall, petroleum products supply over half of the state's total energy needs. Natural gas is important to each of the consuming sectors, but, not surprisingly, is particularly important to the industrial sector. Coal plays a very minor role in the energy picture of the state.

Table VI. Fuel mix by sector in Mississippi in 1974
(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	0.0	52.5	47.5			116.8
Industrial	0.1	15.9	83.4			167.4
Electric utilities	25.1	43.7	31.2	0.0	0.0	140.9
Transportation		78.8	21.2			242.4
Total	5.5	51.2	43.3	0.0	0.0	670.8

Residential. Mississippi has more mobile home and single-family housing units than the national average. Natural gas is the primary fuel for space and water heating as well as cooking. Natural gas usage per capita, however, is low relative to both the region and the nation. Per capita fuel oil usage is 54% less than the national average, natural gas per capita usage is 46% less than the national average, but per capita electricity usage is 22% greater than the national average. Natural gas prices are 18% less than those in other states, and electricity prices 22% less. Kerosene usage per capita is over twice as great as the national average, despite the fact that kerosene prices are 10% higher in Mississippi than elsewhere. These statistics on residential energy usage are summarized in Table VII.

Table VII. Fuel use by the residential sector in Mississippi in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	1.39	0.46	2.62	1.01
Natural gas	0.87	0.54	1.38	0.82
Electricity	0.95	1.22	7.38	0.78
Kerosene	1.44	2.31	3.21	1.10

Commercial. Approximately 59% of the state's employees are engaged in commercial activities. Very few, however, are involved in finance, insurance, real estate, and services relative to the South. Table VIII indicates the fuel mix, equivalent Btu fuel prices paid, and fuel usage per employee in the commercial sector in Mississippi in 1975.

Table VIII. Fuel use by the commercial sector in Mississippi in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Fuel oil	39.8	1.02	2.62	1.01	68.7	1.19
Natural gas	36.0	1.04	0.92	0.70	62.1	1.21
Electricity	24.1	1.08	7.95	0.86	41.6	1.26

Natural gas is used to satisfy 36% of the energy needs of the sector, and is the cheapest fuel relative to what other states pay. Natural gas prices are 30% less than the national average, and fuel oil prices 14% less. On a per employee basis, the commercial sector uses more oil, gas, and electricity than is typical of this sector in other states in the United States.

Manufacturing. Approximately 39% of the state's employment is in the industrial sector, with 82% of these employees engaged in manufacturing activities. Table IX presents energy-intensiveness indices of manufacturing in Mississippi for each 2-digit SIC in 1974. The manufacture of lumber products, fabricated metal, machinery, and instruments each require over three times as much oil per employee as is typical of these industries. Overall, however, the manufacturing sector uses 4% less fuel oil per worker than the national average. Natural gas usage per employee is 48% greater in Mississippi than in other states, the exceptionally high usage occurring in the paper industry. Electricity usage per employee is 20% less than the national average, though the refining of petroleum requires over three times as much electricity per worker as is typical of SIC 29. Overall, energy usage per worker in the manufacturing sector in the state is only slightly higher than the national average. Some industries, however, are overutilizing energy relative to other inputs (petroleum refining, paper manufacturing, lumber products) while others are conserving energy relative to other inputs (transportation equipment, furniture manufacturing, and apparel industries).

The fuel mix of this sector, equivalent Btu fuel prices paid, and fuel usage per employee are shown in Table X, which also relates these energy usage patterns with manufacturing sectors in other states. The sector is seen to be primarily reliant upon natural gas, 42% more so than is typical. Natural gas prices paid by manufacturers are 7% higher than the national average, while most fuel prices are relatively lower. Overall, the sector pays 21% less for energy than do manufacturers in other states. Fuel usage per employee is exceptionally high for natural gas, but lower for electricity.

Electric Utilities. The utilities for Mississippi are most reliant upon oil-fired generation, as is shown in Table XI. This dependence upon oil-fired plants is over three times as great as the national average.

Table IX. Energy-intensiveness indices of manufacturing in Mississippi in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.14		0.85	1.06	0.79
22	0.10		1.79	0.83	0.86
23	0.13		1.18	0.75	0.68
24	3.40		2.99	1.47	1.81
25	0.12		0.77	0.83	0.51
26	2.34		11.47	0.42	2.29
27	0.00		4.85	0.70	1.05
28	0.35		2.70	1.86	1.90
29	0.00		0.00	3.30	2.67
30	0.09		1.35	1.26	0.87
32	0.00		1.74	1.22	1.25
34	3.70		0.70	1.15	1.03
35	3.64		1.04	1.04	0.95
36	0.00		1.79	1.01	1.14
37	0.87		0.21	0.57	0.27
38	3.15		2.21	1.56	1.59
39	2.38		1.49	1.21	1.13
Average	0.96		1.48	0.80	1.04

Table X. Fuel use by the manufacturing sector in Mississippi in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal						
Oil	12.0	0.92	1.71	0.89	24.2	0.95
Gas	69.5	1.42	0.51	1.07	140.6	1.46
Electricity	12.1	0.77	4.34	1.76	24.4	0.79
Coke						
Total	93.6		1.15	0.79	202.3	1.03

Table XI. Fuel use by the electric utility sector
in Mississippi in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	29.2	0.66	0.84	0.97	1419	0.35
Oil	47.9	3.18	1.77	0.88	2332	1.72
Gas	22.9	1.46	0.82	1.09	1114	0.79
Hydropower	0.0					
Nuclear	0.0					
Total	100.0		1.27	1.18	4865	0.54

Natural gas usage is 46% higher than elsewhere. The implication, then, of the National Energy Plan conversion mandate is substantial burden on the utilities of Mississippi. Fuel oil prices are 12% less than the regional average, while natural gas prices are 9% higher. Overall, the price for generating a kilowatt hour of electricity is 18% higher in Mississippi than other states. Fuel oil usage per capita is 72% higher, while coal usage per capita is 65% lower than average. Overall, the sector generates 46% less electricity per capita than most states.

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APPENDIX O
NORTH CAROLINA

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With 9% of the region's population, North Carolina has no fossil fuel production of its own. Table I indicates the generation and capacity of electricity from hydro and nuclear sources in North Carolina in 1975.

Table I. Energy production and reserves in North Carolina in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Coal		830	
Hydropower	24	55	2.3
Nuclear	15	81	5.3
Total	39	966	24.8

There are coal reserves in North Carolina, but there are no active coal mines at this time. The Brunswick Steam Electric Plant of Carolina Power and Light is the state's only nuclear facility which is now operating in Southport. The Shearon Harris plant is scheduled for commercial operation in 1990 (the first unit will become operational in 1984). Duke Power Company has the McGuire Nuclear Station scheduled for operation in 1980 on Lake Norman, and the Perkins Nuclear Station for operation in 1990 in Davie County. There are 26 counties with hydro generation of electricity.

Per capita income is 4% less than the regional average, but the state has 4% more heating degree days. In terms of overall energy consumption per capita, North Carolina is ranked 43rd, indicating a slight relative increase in per capita energy consumption since 1972. Table II shows the per capita energy consumption of each sector by fuel, and Table III indicates how these consumption patterns compare with those of the nation as a whole.

The electric utilities and transportation sectors are the largest per capita energy users in the state. Overall, the state is most reliant upon petroleum, which satisfies almost half the state's total energy requirements. Relative to the nation as a whole, it is the high usage of coal which uniquely characterizes the state. North Carolinians use 53% more coal per capita than the national average, 23% less fuel oil, and 12% less natural gas. Overall, the state consumes 26% less energy per capita than other states. The low rate of energy consumption, however, cannot offset the dearth of energy resources. In 1975 the state imported 4.4 times more energy per capita than the average.

Table II. Per capita energy use in North Carolina in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	1.34	25.45	9.08			35.87
Industrial	6.73	12.22	16.99			35.94
Electric utilities	85.41	6.49	0.20	12.28		104.39
Transportation		76.87	0.86			77.73
Other		1.28				1.28
Total	93.49	122.33	27.13	12.28		255.22

Table III. Ratio of 1974 per capita energy use in North Carolina

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	0.95	0.88	0.26			0.54
Industrial	0.34	0.44	0.36			0.38
Electric utilities	2.12	0.39	0.01	0.78		1.10
Transportation		0.92	0.26			0.89
Other		1.11				1.11
Total	1.53	0.77	0.26	0.78		0.74

THE SUPPLY OF ENERGY: Energy Inputs

As previously noted, there is no natural gas or crude oil production in North Carolina. Table IV illustrates the interstate shipments of natural gas in 1975. Currently all receipts are from South Carolina and all shipments are to Virginia. The major interstate gas pipeline company is Transcontinental Gas Pipe Line Company. There are five intra-state pipeline companies: North Carolina Natural Gas Corporation, Piedmont Natural Gas Company, Public Service Company of North Carolina, United Cities Gas Company, and North Carolina Gas Service. All natural gas distributors in North Carolina (excepting Kings Mountain and Bessemer City) buy gas under TRANSCO's contract demand rate schedule at a daily contract volume. None of the utilities since mid-1971 have been able to purchase full contract demand volumes.

Table IV. Interstate shipments of natural gas
in North Carolina in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	0.0
Receipts	659.8
South Carolina, 100%	
Shipments	541.9
Virginia, 100%	
Retained for consumption	117.9
Consumption	114.8
Change in storage	0.1

Natural gas appears to be the fuel most likely to be in short supply in the immediate future. Under the current FPC schedule, residential and small commercial/industrial users are afforded the highest priority during service curtailments. Due to this priority schedule, North Carolina is likely to suffer curtailments disproportionate to its total share of natural gas demand, since only 38% of consumption is in the residential and small commercial/industrial sectors, the remaining 62% being consumed by the utilities and industrial sectors. The most likely situation is a curtailment in the area of 50+%, with attendant increased demand for propane, middle distillate and residual fuel oils.

Since there are no refineries or processing plants in the state, there are no crude oil shipments. The state imports most of its coal from Kentucky and Virginia by rail for use in electrical generation. Some coal is consumed by the commercial and industrial sectors.

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. North Carolina has approximately forty prime suppliers bringing petroleum products into the state. There are three pipeline systems (Plantation, Colonial, and Dixie) with 815 miles of product pipelines, carrying the major portion of all light products required into the state. Residual fuel is brought into the state by oceangoing tankers from foreign and domestic sources. All deliveries of petroleum products are scheduled well in advance of actual delivery utilizing a complex network of electronic computing equipment.

When products are delivered, they are held temporarily at storage terminals. There are approximately nine of the locations with total capacity of 700 million gallons. There are approximately 19,000 retail outlets and 900 wholesalers who then sell these products directly to consumers. Truck transport is via 600 contract and common motor freight carriers across the state.

The state fears spot shortages in the supply of petroleum products due to interruptions in the transportation and distribution infrastructure (localized pipeline malfunctions, labor actions, terminal fires, etc.). In the longer term, there could be a possible withdrawal of large prime suppliers from the state upon terminating the mandatory allocation system. There are also propane storage, distribution, or daily flow limitations at the Apex Terminal and its associated pipeline.

Electricity. There are three major companies supplying the state: Carolina Power and Light Company, Duke Power Company, and Virginia Electric and Power Company. There was one nuclear facility, 41 hydro plants, and 34 fossil fuel plants operated by these companies in 1975. Over 97% of the total generating capacity is investor-owned. Nuclear capacity accounts for 6% of the total generating capacity, hydro for 12%, and conventional steam generation for 82% of the total. Most plants are coal-fired, such that the conversion mandate of the National Energy Plan should not impose undue hardships on the utilities of the state. Currently, 92% of all coal consumed in North Carolina is burned in electrical generating facilities of the four major utilities.

In analyzing estimated reserve margins, both Carolina Power and Light and Duke Power Company appear to have possible periods of capacity shortages. CP & L, starting with the summer of 1981 and lasting through the summer of 1988, has projected periods of extremely low reserve margins. For the summers of 1982 and 1983, CP & L projected that expected peak load will exceed owned capability plus firm purchases. In comparison, Duke indicates a low reserve level for the summer of 1983 which may cause a slight capacity shortage, while VEPCO appears to have adequate reserves for its system throughout the period.

All three utilities assist one another in supplying load in the form of economy energy (the purchase of surplus base load electricity by one utility from another). Because the purchasing utility pays less for this

surplus electricity than it would cost to produce the additional electricity needed, economy electricity is efficient and economical. In the case of equipment failure, unusual load demands, or other abnormal conditions, these utilities have emergency service agreements. Each utility will assist a neighboring utility up to reducing voltage 5%. The assisting utility will not disconnect customers from its system to supply service to customers on another utility's system, however.

THE DEMAND FOR ENERGY

A summary of the fuel mix of each sector and its total Btu usage is shown in Table V. As noted, it is the electric utilities which consume the bulk of the energy imported into the state. They are most reliant upon coal, whereas the residential-commercial sector is primarily reliant upon fuel oil, and the industrial sector upon natural gas. Nuclear sources of generation were not operable in 1974, but are now contributing to the energy needs of the state.

Table V. Fuel mix by sector in North Carolina in 1974
(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	3.7	71.0	25.3			192.8
Industrial	18.7	34.0	47.2			193.2
Electric utilities	81.8	6.2	0.2	11.8	0.0	561.1
Transportation		98.9	1.1			417.8
Total	36.6	48.0	10.6	4.8	0.0	1371.9

Residential. Table VI indicates the fuel usage per capita of the residential sector in North Carolina relative to the South and to the nation in 1975. Also shown are equivalent Btu fuel prices and how they compare with the national average. There is an unusually large number of mobile homes in the state, contributing to higher than average per capita usage of both kerosene and LPG. Fuel oil is the primary means of space heating, while electricity is the most important fuel for water heating and cooking in North Carolina. The saturation of dishwashers and clothes dryers is very low relative to the nation.

Fuel oil usage per capita is seen to be twice as great as the regional average, but 27% less than the national average. Most notable, however, is very low per capita usage of natural gas--78% lower than the national average. Electricity usage per capita is 28% higher than the average.

Table VI. Fuel use by the residential sector
in North Carolina in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	2.22	0.73	2.59	1.00
Natural gas	0.35	0.22	1.98	1.19
Electricity	0.99	1.28	8.52	0.91
Kerosene	2.32	3.72	2.71	0.93

Natural gas prices are 19% higher than elsewhere, fuel oil prices approximately the same, and electricity prices 9% lower on average.

Commercial. About half of the state's employees are engaged in commercial activities. This employment mix indicates commercial employment in North Carolina is 18% less significant than elsewhere in the South and 20% less significant than elsewhere in the nation. Table VII indicates the fuel mix of the sector, equivalent Btu fuel prices paid, and fuel usage per commercial employee. The sector is seen to be most reliant upon petroleum and electricity, but 46% less reliant upon natural gas. Electricity prices are 15% lower and natural gas prices 29% higher than the national average. On a per employee basis, electricity usage is 27% higher, coal usage 16% higher, and natural gas usage 59% lower. Fuel oil usage per employee is somewhat less than the average elsewhere in the United States.

Table VII. Fuel use of the commercial sector
in North Carolina in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	6.1	1.51			6.9	1.16
Oil	38.5	0.99	2.59	1.00	43.8	0.76
Gas	18.7	0.54	1.71	1.29	21.2	0.41
Electricity	36.8	1.65	7.82	0.85	41.9	1.27

Manufacturing. Industrial employment accounts for 45% of the total and 87% of these employees are engaged in manufacturing activity. Table VIII presents energy-intensiveness indices for each two-digit SIC in North Carolina in 1974. Oil usage per employee is 52% less than the national average, coal usage is 15% less, natural gas usage 74% less, and electricity usage 13% less than the average. Overall, manufacturing

Table VIII. Energy-intensiveness indices of manufacturing in North Carolina in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.97	0.00	0.40	0.80	0.52
21	1.35	0.78	0.48	1.07	1.64
22	1.10	1.22	0.78	1.18	0.97
23	1.28	6.72	0.60	0.72	0.78
24	1.64	5.38	0.20	0.85	0.91
25	1.74	1.86	0.23	1.15	0.77
26	2.46	3.53	0.28	1.08	1.66
27	0.46	0.00	0.71	1.20	1.03
28	3.04	0.34	0.31	0.73	0.64
29	4.39	0.00	0.04	1.06	0.49
30	0.83	0.00	0.43	0.81	0.58
31	1.46	0.00	0.00	1.49	1.06
32	1.04	0.40	0.60	0.89	0.67
33	0.16	0.86	0.38	2.32	0.79
34	0.62	0.00	0.37	0.76	0.51
35	0.62	0.00	0.39	1.16	0.68
36	2.52	0.00	0.52	1.80	1.25
37	0.70	0.28	0.30	0.81	0.58
38	2.18	0.08	2.44	1.65	1.47
39	1.34	0.00	0.77	1.26	0.88
Average	0.47	0.85	0.26	0.87	0.58

employees in the state use 42% less energy per worker than manufacturing employees in other states. The paper and tobacco industries, however, use over 60% more energy per worker than is typical of these industries. Conversely, the food, rubber-plastics, fabricated metals, and transportation equipment industries use substantially less energy than is typical.

Table IX indicates the fuel mix, equivalent Btu fuel prices, and fuel usage per employee in the sector in 1974. The sector is primarily reliant upon oil. This is unique in that the industrial sector as a whole is primarily reliant upon natural gas. The heavy reliance upon oil by manufacturers in the state is twice as great as the national average.

Coal prices paid are 45% higher than the average, natural gas prices 33% higher, and electricity and fuel oil prices approximately the same. Overall, fuel prices paid by the sector are 39% higher in North Carolina than in other states. On a per employee basis, only oil is utilized to an atypical extent. Overall, fuel usage per worker by the sector is 43% less than the national average.

Table IX. Fuel use by the manufacturing sector
in North Carolina in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	13.7	1.46	1.26	1.45	15.3	0.83
Oil	30.5	2.35	1.87	0.98	34.0	1.34
Gas	22.0	0.45	0.88	1.33	24.6	0.26
Electricity	23.5	1.49	4.13	1.02	26.2	0.85
Coke	0.1	0.05	1.75	1.14	0.1	0.00
Total	89.8		2.01	1.39	111.7	0.57

Electric Utilities. Table X indicates the fuel mix, equivalent Btu fuel prices paid, and fuel usage per capita of the electric utilities in 1975. The sector is most reliant upon coal, 88% more so than is generally the case. Coal prices, however, are 37% higher than the national average, and natural gas prices 70% higher. Overall, the cost of generating a kilowatt hour of electricity is 10% higher in North Carolina than elsewhere. On a per capita basis, coal usage is over twice as great, and per capita electrical generation 9% higher than the average.

Table X. Fuel use of the electric utility sector
in North Carolina in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	83.8	1.88	1.18	1.37	8204	2.05
Oil	0.3	0.02	2.09	1.04	27	0.02
Gas	0.0		1.28	1.70	1	0.00
Hydropower	13.2	0.84			1294	0.92
Nuclear	2.7	0.30			265	0.33
Total	100.0		1.18	1.10	9787	1.09

ENVIRONMENTAL AND POLITICAL ISSUES

The North Carolina Energy Policy Act of 1975 created an Energy Policy Council for the purpose of advising and making recommendations on energy policy and programs to the governor and general assembly. Among the responsibilities is the creation of a central repository for the collection

and storage of data and information on energy-related matters. The Energy Policy Council is recommending that an Energy Information Section be established in the Energy Division, Department of Military and Veteran Affairs to accomplish this responsibility.

APPENDIX P

OKLAHOMA

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Oklahoma has 4% of the region's population and is most noted for its open ranges and farmland. Almost 60% of its energy production is natural gas. Table I shows the production and reserves of energy in the state in 1975. There are no nuclear facilities in the state at this time, but the Public Service Company of Oklahoma has the Black Fox station scheduled for commercial operation in 1985. There are eight counties engaged in hydro generation of electricity. While coal production is currently relatively small, there are substantial coal reserves remaining.

Table I. Energy production and reserves in Oklahoma in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Crude oil	946	7,190	7.6
Natural gas	1,755	14,300	8.1
Natural gas liquids	169	1,206	7.1
Coal	72	32,666	450.6
Hydropower	10	29	2.8
Total energy	2,952	55,391	18.8

Per capita income is approximately equivalent to the regional average. There are 31% more mean heating degree days in Oklahoma than in other states in the South. In terms of per capita energy consumption, the state is ranked 12th in the nation. Table II indicates the per capita energy usage of each sector by fuel in 1974. Table III compares these energy utilization patterns with those of the United States as a whole.

With a comparative advantage in the production of natural gas, it is not surprising that natural gas satisfies 64% of the total energy requirements of the state. All sectors, except for transportation, are primarily reliant upon natural gas. The largest per capita energy user is the electric utility sector, but the industrial and transportation sectors are also relatively large energy users.

Relative to the nation, per capita coal usage is extremely low, petroleum usage 18% less than average, and hydro usage 11% less than average. Per capita natural gas usage, however, is 2.5 times as great as is typical. Relative to the nation, again the electric utilities are seen to be the unusually large energy consumers. Overall the state uses 17% more energy per capita than the average state. Despite its relatively high rate of consumption, the state is able to export almost 60% of all the energy it produces.

Table II. Per capita energy use in Oklahoma in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	0.04	27.30	43.42			70.76
Industrial	1.60	9.18	90.15			100.93
Electric utilities		0.78	114.10	13.95		128.83
Transportation		91.50	9.18			100.61
Other		0.90				0.90
Total	1.64	129.65	256.81	13.95		402.05

Table III. Ratio of 1974 per capita energy use in Oklahoma

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	0.03	0.95	1.22			1.07
Industrial	0.08	0.33	1.90			1.06
Electric utilities		0.05	6.87	0.89		1.36
Transportation		1.09	2.83			1.16
Other		0.77				0.77
Total	0.03	0.82	2.50	0.89		1.17

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas: Natural gas production began in 1902, and there are now 72 counties with either oil or gas production (94% of the total). Natural gas is the second most valued mineral product in the state. Approximately 25% of the total land area has been proven productive or is currently under exploration lease. Very few new discoveries of natural gas have occurred over the last five years, however. Average annual production, nonetheless, has been increasing over time. Production peaked in 1972, and has been declining ever since (see Figure 1). The average annual depletion rate is about the same as the national average, but only 21% of the proven recoverable reserves remain. If we add the extensions and revisions likely to be forthcoming during the next twenty-five years, assuming there will be adequate price incentives, it appears that Oklahoma will have natural gas reserves until 1992. This is contingent upon production rates remaining at 1976 levels, and no increase in the amount of gas being exported (54% of production).

Table IV indicates the interstate shipments of natural gas in Oklahoma in 1975. The bulk of the natural gas is shipped via pipeline to Kansas. The natural gas pipeline network is extensive, but perhaps the major company is Oklahoma Natural Gas Company.

Table IV. Interstate shipments of natural gas
in Oklahoma in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	1605.4
Receipts	1166.9
Texas and Missouri, 100.0%	
Shipments	2036.3
Kansas, 90.1%	
Arkansas, 6.2%	
Colorado, 3.7%	
Retained for consumption	736.0
Consumption	728.8
Δ Underground storage	+3.0

Crude Oil. Oklahoma is a net exporter of crude oil as well as natural gas. Production of oil began in 1891, peaked in 1927, and has been declining since 1968. Figure 2 charts this production history of the state. Though the annual depletion rate is less than that of the region or the nation, only 10% of the proven recoverable resource base remains. If we add the

Fig. 1. Oklahoma gas production.

Fig. 2. Oklahoma oil production.

the indicated reserves and probable extensions and revisions likely to occur over the next twenty-five years, it appears that Oklahoma will have its own crude oil until 1990.

Table V indicates the interstate shipments of crude oil in the state in 1975. Approximately 6% of the crude oil receipts are from foreign sources, the bulk of the oil being shipped from Texas. Most of Oklahoma's shipments are to Kansas, Illinois, and Indiana. Tulsa is a focal point for all major crude oil pipelines. All interstate shipments are sent via pipeline as are 97% of the intrastate shipments. Foreign receipts of crude oil are also via pipeline. There are approximately 13,600 miles of pipeline in the state, 34% of which are trunk lines, 44% gathering lines, and 22% product lines.

Table V. Interstate shipments of crude oil
in Oklahoma in 1975

	Amount (bbl $\times 10^3$)
Production	163,123
Receipts	46,974
Texas, 85.9%	
Foreign sources, 6.8%	
New Mexico, 5.2%	
Wyoming, 1.3%	
Utah, 0.5%	
Colorado, 0.2%	
Shipments	57,511
Kansas, 43.3%	
Illinois, 29.8%	
Indiana, 19.1%	
Missouri, 4.2%	
Pennsylvania, 1.5%	
Ohio, 1.0%	
Minnesota and Wisconsin, 0.7%	
Louisiana, 0.3%	
Retained for consumption	152,586
Δ Stocks	61
Refinery loss	22
Crude runs to stills	167,132

Coal. There are 14 active coal mines in the state, with production in Craig, Haskell, LeFlore, Muskogee, Nowata, Pittsburgh, and Rogers counties. Oklahoma is a net exporter of coal, with the bulk of shipments going by rail to Missouri and Kansas. Table VI indicates the shipments of bituminous coal in Oklahoma in 1975.

Table VI. Shipments of bituminous coal
in Oklahoma in 1975
(tons $\times 10^6$)

Total production	2872
Shipments	2871
Rail, 81.7%	
Truck, 9.6%	
Water, 8.7%	
Nonmarketed production	1
Mine-mouth facilities, 0.0%	
Other, 100.0%	
Receipts	19
Electric utilities, 0.0%	
Coke and gas plants, 0.0%	
Retail dealers, 10.5%	
Other, 89.5%	

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. There are 12 refineries in the state with a capacity of 557.9 thousand barrels of oil per stream day. The largest refineries are the Sun Oil Company plant in Tulsa and the Continental Oil Company plant in Ponca City. Oklahoma is ranked 3rd in the region in terms of its petroleum production. Major product lines connect Oklahoma with Texas and Kansas, and with major consuming markets in the midwest (Chicago).

There are 81 natural gas processing plants with a capacity of over 3.1 billion cubic feet of gas per day. In 1975 the state produced over 83 billion barrels of raw NGL, LPG, propane, and other products. The average plant operated at 72% of capacity in 1975.

Electricity. There are 10 hydro plants in the state and 59 fossil fuel plants, with most of the latter being gas-fired. Approximately 80% of the total generating capacity is investor-owned. Currently 86% of the generation is from conventional steam, 12% from hydro sources, and 2% from internal combustion processes. Per capita electrical generation is 37% higher than the national average.

THE DEMAND FOR ENERGY

Table VII summarizes the fuel mix of each sector in the state in 1974. The utilities are the largest energy users, followed by the industrial and transportation sectors. Coal supplies less than 1% of the total energy needs of the state. All sectors have a relatively high mix of natural gas.

Table VII. Fuel mix by sector in Oklahoma in 1974
(Btu $\times 10^{12}$)

Sector	Percentage				Total
	Coal	Oil	Gas	Hydropower	
Residential-commercial	0.0	38.6	61.4		189.7
Industrial	1.6	9.1	89.3		270.6
Electric utilities	0.0	0.6	88.6	10.8	345.4
Transportation		90.9	9.1		269.9
Total	0.4	32.2	63.9	3.5	1078.0

Residential. Unlike most states in the South, Oklahoma does not have an unusually large number of mobile homes. Two-family and multiple housing units atypically characterize the housing stock of the state. Natural gas is the primary fuel for space and water heating as well as cooking. The saturation rate of airconditioners per household is 64% higher than the national average. Table VIII indicates the fuel usage of this sector relative to the region and the nation and shows equivalent Btu fuel prices paid.

Table VIII. Fuel use by the residential sector in Oklahoma in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	0.83	0.28	2.55	0.99
Natural gas	2.03	1.28	1.19	0.71
Electricity	0.93	1.20	7.52	0.80
Kerosene	0.29	0.46	2.82	0.97

Natural gas usage per capita is twice the regional average and 28% higher than the national average. Electricity usage per capita is 20% higher than the national average, but fuel oil and kerosene are relatively underutilized. All fuel prices are relatively cheaper in Oklahoma than elsewhere, notably natural gas, which is 29% less than the national average. Electricity prices are 20% lower.

Commercial. Approximately 68% of the state's employees are engaged in commercial activities. Relative to the region, Oklahoma has 19% more commercial employees in governmental service. Table IX indicates the fuel mix of the sector, equivalent Btu fuel prices paid, and fuel usage per commercial employee in Oklahoma in 1975. Both natural gas and electricity are relied upon to a greater extent than is typical. Natural gas prices are 31% less, electricity prices 33% less, and fuel oil prices approximately the same. On a per employee basis, commercial gas usage is 37% higher than average. Electricity usage is 30% higher in the commercial sector in Oklahoma than in other states.

Table IX. Fuel use by the commercial sector in Oklahoma in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	0.1	0.02			0.2	0.03
Oil	32.1	0.82	2.55	0.99	53.8	0.94
Gas	42.4	1.22	0.92	0.69	71.1	1.39
Electricity	25.4	1.14	6.23	0.67	42.6	1.30

Agriculture. The Bureau of Mines includes agricultural energy use in the residential-commercial sector, such that a precise estimate of the specific energy use of this sector cannot be obtained. It is known that agriculture, however, is a very large income generator for Oklahoma. There are approximately 80,000 farms with an average size of 460 acres. Some 6% of the work force is involved in direct food production, and 24% of the work force is involved in the total food chain. Cash receipts from the sale of farm products account for \$2 billion in income.

Agriculture is generally energy dependent, but fuel efficient. For all U.S. agriculture, one unit of fuel energy consumed produces approximately 0.6 of a unit of food energy produced. In Oklahoma, for each unit of fuel energy consumed, 1.3 units of food energy are produced.

Irrigation is a year-round project, though it is more intensive in the summer than any other season. The water is pumped by 100-150 hp pumps powered by natural gas. Conversion to electric pumps would be costly, and pumps with more than 20 hp require 3-phase motors. There are no 3-phase power sources available in the rural areas of Oklahoma.

If a farmer hooks up between the collector line and a gas-producing well, he must go without gas for six weeks during the annual testing period. If he hooks up downstream of the collector line, he must pay more for the gas, but will not be subjected to a six-week shutdown. Under the National Energy Plan, however, this gas is subject to curtailment. In either situation, then, the farmer may be subjected to expensive extended cutoffs of service for irrigation pumps and risks heavy crop damage.

Manufacturing. Only 27% of the state's employees are in the industrial sector (13% less than the national average). Of these, 67% are engaged in manufacturing activities. Table X indicates energy-intensiveness indices for each two-digit SIC in the state in 1974. Coal usage is zero, and oil usage per employee is 90% less than the national average. Natural gas usage, however, is approximately 91% higher than the average. Overall, total energy usage per worker is 19% higher in Oklahoma than elsewhere.

Table X. Energy-intensiveness indices of manufacturing in Oklahoma in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.06		0.75	0.95	0.63
22	0.00		3.20	0.63	1.11
23	0.00		0.76	0.52	0.54
24	0.13		3.75	1.00	1.38
25	0.00		1.75	0.91	1.16
27	0.00		0.41	0.92	0.89
28	0.00		4.65	1.08	1.32
29	0.32		1.60	0.97	1.34
30	0.13		3.12	1.59	1.60
32	0.07		1.01	0.89	0.83
33	0.09		1.06	0.63	0.73
34	0.08		0.60	0.48	0.54
35	0.17		0.70	0.92	0.65
36	0.09		2.92	0.57	0.59
39	0.00		1.18	0.30	1.34
Average	0.10		1.91	0.78	1.19

The chemicals, lumber, textiles, and rubber-plastics industries each use over 3 times as much gas per employee as is typical. The rubber-plastics industry uses 59% more electricity than is generally the case, and is the largest energy user per worker in the state. The smallest energy users (per worker) are the apparel and fabricated metal industries.

Table XI indicates the fuel mix, equivalent Btu fuel prices, and fuel usage per worker of this sector in 1974. As noted, natural gas is the primary fuel utilized--61% more so than is typical. Natural gas prices are 25% less than the national average, electricity prices 21% less, and fuel oil prices 17% less. Overall, the cost of fuel is 43% less in Oklahoma than other states. (On a per employee basis, the statistics are the same as reported in Table IX.)

Table XI. Fuel use by the manufacturing sector in Oklahoma in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal						
Oil	1.1	0.08	1.60	0.83	2.5	0.10
Gas	78.9	1.61	0.50	0.75	180.0	1.87
Electricity	10.3	0.66	3.20	0.79	23.6	0.76
Coke						
Total	90.3		0.84	0.57	228.2	1.16

Electric Utilities. Table XII indicates the fuel mix, equivalent Btu fuel prices paid, and fuel usage per capita of the electric utilities in Oklahoma in 1975. Natural gas contributes 91% to the total amount of electricity generated. This dependence on natural gas for electrical generation is almost 6 times as great as elsewhere. The implications of the conversion mandate of the National Energy Plan are, therefore, severe for Oklahoma utilities. Currently coal prices are twice as high in Oklahoma as elsewhere while natural gas prices are 19% less. Overall, the cost of generating a kilowatt hour of electricity is 44% less in Oklahoma than in other states and are the lowest in the region.

Table XII. Fuel use by the electric utility sector in Oklahoma in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	0.0		1.78	2.06		
Oil	0.1	0.01	1.71	0.85	14	0.01
Gas	91.0	5.82	0.61	0.81	11,164	7.94
Hydropower	8.9	0.57			1,086	0.77
Nuclear	0.0					
Total	100.0		0.61	0.56	12,264	1.36

APPENDIX Q
SOUTH CAROLINA

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There are no fossil fuels produced in South Carolina, which has 4% of the region's population. Nor are there any refineries or natural gas processing plants located in the state. Table I indicates the energy production and reserves in South Carolina in 1975.

Table I. Energy production and reserves in South Carolina in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Hydropower	14.9	52.4	3.5
Nuclear	207.5	320.3	1.5
Total	222.4	372.7	1.7

There are fourteen counties in the state with hydro generation capacity. Carolina Power and Light operates the Robinson nuclear plant in Hartsville and Duke Power Company operates the Oconee station in Seneca. They have scheduled the Catawba station for 1983 in Lake Wylie and the Cherokee station for 1989 in Cherokee County. South Carolina Electric and Gas Company has the Virgil Summer station scheduled for completion in 1979 in Fairfield County.

Per capita income is 10% less than the regional average, and there are 19% fewer mean heating degree days. South Carolina and Mississippi share in the plight of unusually low per capita incomes. Overall, South Carolina is ranked 38th in its per capita energy consumption. This represents a relative increase in per capita energy consumption since 1972, when the state was ranked 41st. Table II presents the per capita energy usage for each sector by fuel, and Table III indicates how these energy utilization patterns compare with the national average. The state is most reliant upon petroleum, which supplied 40% of the total energy requirements of the state in 1974. The largest energy user is the electric utility sector, which utilizes both coal and nuclear power for the bulk of generation.

Per capita nuclear energy is 7 times the national average, while oil and gas are relatively underutilized. Overall the state consumed 13% less energy per capita than other states. Despite heavy reliance upon nuclear energy sources and relatively low per capita consumption rates, South Carolina remains a heavy importer of energy. In 1975 per capita energy imports of the state were more than 5 times the average.

Table II. Per capita energy use in South Carolina in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	1.69	18.45	12.94			33.08
Industrial	12.11	11.46	28.76			52.32
Electric utilities	56.11	13.73	7.96	15.93	42.49	136.22
Transportation		76.54	0.79			77.33
Other		0.58				0.58
Total	69.91	120.76	50.49	15.93	42.49	299.57

Table III. Ratio of 1974 per capita energy use in South Carolina

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	1.20	0.64	0.36			0.50
Industrial	0.62	0.41	0.61			0.55
Electric utilities	1.39	0.83	0.48	1.02	7.42	1.44
Transportation		0.91	0.24			0.89
Other		0.50				0.50
Total	1.14	0.76	0.49	1.02	7.42	0.87

THE SUPPLY OF ENERGY: Energy Inputs

There is no production of natural gas in the state, such that gas is currently imported from Georgia from the Transcontinental Gas Pipe Line Corporation and Southern Natural Gas Company. Like Georgia, the state serves as a large intermediary of natural gas from the Gulf, sending most of its gas receipts to North Carolina. (South Carolina Electric and Gas Company and Carolina Pipeline Company are the major intrastate companies.) Table IV indicates the interstate shipments of natural gas in 1975.

Table IV. Interstate shipments of natural gas
in South Carolina in 1975

	Amount ($\text{ft}^3 \times 10^9$)
Marketed production	0.0
Receipts	786.9
Georgia, 100.0%	
Shipments	659.8
North Carolina, 100.0%	
Retained for consumption	127.1
Consumption	122.9
Δ Underground storage	-0.0

There is no production of crude oil in the state, nor are there any refineries. Thus, there are no shipments of crude oil, and the state imports its petroleum products from other states.

There are no active coal mines, and no coal reserves in South Carolina. Most of its coal is imported from Kentucky via rail.

THE SUPPLY OF ENERGY: Energy Outputs

Electricity. There are 25 hydro plants, 2 nuclear plants, and 37 fossil fuel plants in the state. The bulk of the fossil fuel plants are coal-fired, with most of the coal being imported from Kentucky. Approximately 86% of the total generation capacity is investor-owned. Currently, 52% of the capacity is from conventional steam plants, 32% from nuclear plants, and 16% from hydro plants. There is no generation from internal combustion processes. Per capita electrical generation is 53% higher than the national average.

THE DEMAND FOR ENERGY

A summary of the fuel mix of each sector and its total Btu consumption is presented in Table V. As previously noted, the predominant fuel is oil and the predominant sector the electric utilities. The industrial sector is most dependent upon natural gas, the residential sector upon petroleum, and the utilities upon coal. There is very little natural gas used by the transportation sector.

Table V. Fuel mix by sector in South Carolina in 1974
(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	5.1	55.8	39.1			91.8
Industrial	23.1	21.9	55.0			145.2
Electric utilities	41.2	10.1	5.8	11.7	31.2	378.0
Transportation		99.0	1.0			214.6
Total	23.3	40.3	16.9	5.3	14.2	831.2

Residential. South Carolina has twice as many mobile homes as is typical of the nation and 20% more single-family housing units. Oil is used for space heating, while electricity is generally used for water heating and cooking. Residents have relatively few dishwashers and clothesdryers. Table VI indicates the fuel usage of the sector relative to the region and the nation and also compares the equivalent Btu fuel prices paid. Fuel oil usage is 22% greater than in the region, but national patterns indicate relatively high electricity usage per capita and little fuel oil and natural gas usage. Electricity prices are 7% lower in South Carolina than in other states, while natural gas prices are 25% higher than the average. Fuel oil and kerosene prices are approximately the same as those prevailing elsewhere. Kerosene and LPG usage are atypically high in South Carolina given the large number of mobile homes and urban-rural mix of the population.

Commercial. Over half of the state's employees are engaged in commercial activities. Overall, the state has 15% fewer employees in this sector than is typical of the region. Representation in finance, insurance, real estate, and service employment is particularly low. Table VII indicates the fuel mix of this sector, the equivalent Btu fuel prices paid, and fuel usage per commercial employee. The sector is most reliant upon electricity, though relative to the nation has an unusually high usage rate of coal and electricity and low usage rate of natural gas. Fuel oil prices are approximately the same, natural gas prices 7% lower, and electricity prices 14% lower. On a per employee basis, coal usage

Table VI. Fuel use by the residential sector in South Carolina

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	1.22	0.41	2.62	1.01
Natural gas	0.45	0.28	2.09	1.25
Electricity	0.97	1.25	8.79	0.93
Kerosene	0.86	1.38	3.02	1.04

Table VII. Fuel use by the commercial sector in South Carolina in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	8.3	2.05			8.7	1.47
Oil	22.5	0.58	2.62	1.01	23.8	0.41
Gas	30.9	0.89	1.23	0.93	32.6	0.64
Electricity	38.3	1.72	7.91	0.86	40.5	1.23

is 47% higher than the national average, electricity usage 23% higher. Natural gas usage is 36% lower and fuel oil usage 59% lower than the average. The heavy reliance upon electricity is to be expected given the state's comparative advantage in electrical generation and the lower relative prices of electricity.

Manufacturing. Approximately 45% of the state's employees are in the industrial sector. Of these, 82% are engaged in manufacturing activities. Table VIII indicates the energy-intensiveness of each two-digit SIC in the state in 1974. Per employee oil usage is 44% higher than the national average, coal usage is 43% higher, natural gas usage is 46% lower, and electricity usage 26% higher. Overall, however, energy usage per worker in the state was 15% lower than the national average. The paper industry uses approximately 3 times the amount of oil per worker as is typical, and 70% more total energy per worker than the average, and is the largest per employee energy user in the state. Coal usage is atypically high in the manufacture of machinery, food, chemicals, and tobacco. Natural gas usage is unusually high in the manufacturing of instruments. The manufacturing of primary metal requires excessive amounts of electricity per worker. The lowest energy users are the manufacturers of transportation equipment, fabricated metal, food, and chemicals.

Table VIII. Energy-intensiveness indices of manufacturing in South Carolina in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.89	2.83	0.41	0.70	0.52
22	0.96	1.75	1.24	1.47	1.19
23	0.52	0.00	0.42	1.40	1.96
24	1.59	0.00	0.90	0.92	1.11
25	0.67	0.00	0.49	1.45	0.66
26	3.16	0.53	0.82	2.01	1.70
28	0.54	2.09	0.17	0.73	0.57
30	1.22	0.00	2.20	1.67	1.48
32	1.17	0.00	1.50	1.40	1.10
33	0.51	0.00	1.26	2.69	1.27
34	0.27	0.00	0.30	0.77	0.38
35	0.52	8.90	1.04	1.75	1.13
36	0.53	0.00	1.06	1.53	1.06
37	0.90	0.00	1.10	0.59	0.35
38	0.89	0.00	3.40	1.80	1.47
39	0.32	0.00	1.42	1.31	0.54
Average	1.44	1.43	0.54	1.26	0.85

Table IX indicates the fuel mix of this sector, equivalent Btu fuel prices paid, and fuel usage per employee. The sector is most reliant upon natural gas, but is atypical in its use of all other fuels. Both coal and oil usage appear unusually high. Coke prices are 79% higher, coal prices 53% higher, and natural gas prices 14% higher. Electricity prices are about the same. Overall, the cost of fuel to the sector is 25% greater than the national average.

Table IX. Fuel use by the manufacturing sector in South Carolina in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	15.7	1.68	1.32	1.53	26.2	1.43
Oil	21.8	1.68	1.71	0.89	36.5	1.44
Gas	30.7	0.63	0.76	1.14	51.3	0.53
Electricity	23.2	1.47	3.98	0.98	38.8	1.26
Coke	0.0	0.01	2.74	1.79	0.0	0.00
Total	91.4		1.82	1.25	167.2	0.85

Electric Utilities. Between 1974 and 1975, South Carolina became more reliant upon nuclear sources for electrical generation than coal. This dependence upon nuclear power is 5 times the national average. Table X indicates the fuel mix, equivalent Btu fuel prices paid, and the fuel usage per capita of this sector in 1975. Coal prices were 43% higher, and fuel oil prices 41% lower. The overall cost of generating a kilowatt hour of electricity is 9% above the national average. Per capita usage of coal, oil, and gas are less than the average, while hydro usage is 11% higher in South Carolina. Note that per capita nuclear usage is almost 9 times as great as the average.

Table X. Fuel use by the electric utility sector
in South Carolina in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	27.2	0.61	1.24	1.43	3,725	0.93
Oil	7.4	0.49	1.17	0.59	1,014	0.75
Gas	3.6	0.23	0.75	1.00	486	0.35
Hydropower	11.3	0.72			1,550	1.11
Nuclear	50.5	5.63			6,905	8.56
Total	100.0		1.17	1.09	13,680	1.52

This concentration upon nuclear energy sources is not unusual given the state's lack of fossil fuel resources and increasing uncertainty associated with natural gas availability. It is likely that most of the residents will shift toward higher electrical use, and lower oil usage in the future. Currently per capita electrical generation is 52% higher than the national average.

APPENDIX R
TENNESSEE

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Tennessee has 7% of the region's population. There is little oil and gas production, with coal production amounting to 83% of total energy produced in the state. Table I indicates the production and proved reserves of energy in Tennessee in 1975. There are 22 counties engaged in hydrogeneration of electricity. There are no nuclear facilities currently in operation, but TVA has scheduled the Sequoyah Nuclear Power Plant in Daisy for 1978, the Watt's Bar Nuclear Plant in Spring City for 1980, and 4 units in Hartsville in 1984. The Clinch River Breeder Reactor in Oak Ridge has been the subject of considerable political debate and its future is uncertain.

Table I. Energy production and reserves in Tennessee in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Crude oil	4	9	2.2
Natural gas	0	7	245.6
Coal	215	25,852	120.2
Hydropower	40	65	1.6
Total energy	259	25,933	100.1

Per capita income is 5% lower than the regional average and there are 21% more mean heating degree days in Tennessee than the average southern state. In terms of its per capita energy consumption, Tennessee is ranked 28th in the nation. Its relative per capita energy consumption has increased since 1972 (then ranked 31st in the nation). Table II indicates the per capita energy consumption by sector and fuel of the state in 1974. Table III compares these energy utilization patterns with those of the nation as a whole. The state is most dependent upon petroleum, but coal usage per capita is almost as great. The largest energy user is the electric utility sector which consumes 37% of the total. The residential, commercial, and industrial sectors are primarily dependent upon natural gas, the utilities upon coal.

Relative to the nation, coal usage is 65% greater, while oil and gas are relatively underutilized. The residential, commercial, and industrial sectors are fairly small energy users, consuming 41% less energy than their counterparts in other states. Overall, Tennessee residents consume 14% less energy per capita than the national average. Despite the low rate of energy usage, however, the state is forced to import over 5 times as much energy per capita as the average state.

Table II. Per capita energy use in Tennessee in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	1.54	15.11	21.72			38.37
Industrial	14.10	5.38	37.09			56.54
Electric utilities	85.47	0.55		24.73		110.75
Transportation		85.08	5.91			90.99
Other		0.31				0.31
Total	101.11	106.44	64.69	24.73		296.96

Table III. Ratio of 1974 per capita energy use in Tennessee

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	1.10	0.52	0.61			0.58
Industrial	0.72	0.19	0.78			0.59
Electric utilities	2.12	0.03		1.58		1.17
Transportation		1.01	1.82			1.04
Other		0.27				0.27
Total	1.65	0.67	0.63	1.58		0.86

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. Production of gas first began in 1889, though the first year of recorded production was in 1905. There are 11 counties with either oil or gas production today. Only 10% of the total land area has been proven productive or is under exploration lease. Natural gas is not a major mineral product of the state, and there has never been a lot of natural gas produced. Approximately 69% of the proven recoverable reserves remain--2.3 times the amount remaining in the nation as a whole. If production rates do not increase, and we add the probable extensions and revisions likely to occur over the next twenty-five years, Tennessee could have 140 years of natural gas. This is somewhat unlikely, however, in that the state is importing virtually all its natural gas needs from Mississippi and Alabama. Table IV indicates the interstate shipments of natural gas in the state in 1975.

Table IV. Interstate shipments of natural gas
in Tennessee in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	0.03
Receipts	3911.90
Mississippi, 71.6%	
Alabama, 28.0%	
Georgia, 0.4%	
Shipments	3690.70
Kentucky, 99.8%	
Virginia, 0.2%	
Retained for consumption	221.23
Consumption	217.33
Δ Underground storage	+0.53

There are several major interstate pipeline companies serving the state. East Tennessee Natural Gas Company is the major intrastate pipeline company. Most shipments are to Kentucky via Tennessee Gas Pipeline Company, Columbia Gulf Transmission Company, Texas Eastern Transmission Corporation, or Texas Gas Transmission Corporation.

Crude Oil. Crude oil production began in 1860, though the first year of recorded production is 1916. Only a nominal amount of oil is produced in the state, production peaking in 1974. The average annual production has increased considerably over time, however, and the annual depletion rate is almost 4 times greater than the national depletion rate. Only 31% of the proven recoverable reserve base remains. If 1976 production

rates continue and no new discoveries are made, Tennessee will exhaust its domestic oil reserves by 1981. There are no indicated reserves to supplement the proved reserves in the state, and the U.S. Geological Survey estimates that no extensions and revisions to reserves are likely to be forthcoming.

Currently the state imports 97% of its crude oil needs, with 37% of these imports coming from foreign sources. In 1972 all receipts were from the Gulf Coast. Table V indicates the interstate shipments of crude oil in the state in 1975. There are 707 miles of pipeline in the state, only 22% of which are crude trunk lines. A major oil pipeline crosses western Kentucky, Tennessee, and northwestern Mississippi, while another connects Knoxville and Chattanooga with the Birmingham area, then extends to the oil fields of the Louisiana Gulf Coast.

Table V. Interstate shipments of crude oil
in Tennessee in 1975

	Amount (bbl $\times 10^3$)
Production	682
Receipts	14,384
Foreign sources, 37.4%	
Texas, 34.0%	
Louisiana, 22.5%	
Mississippi, 6.1%	
Shipments	0
Retained for consumption	15,066
Δ Stocks	-17
Refinery loss	17
Crude runs to stills	14,789

Coal. There are 125 active coal mines located in 16 counties in Tennessee. The state is a net importer of coal, with 82% of these imports coming from Kentucky. Both rail and truck shipments are used to transport the bulk of this coal to the electric utilities. Table VI indicates the shipments of bituminous coal in the state in 1975.

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum. There is only one refinery in the state--the Delta Refining Company in Memphis. Capacity is 44.8 thousand barrels of crude oil per stream day. Delta also has asphalt production capacity amounting to 8,000 barrels per day. The state, of course, is a net importer of petroleum products.

Table VI. Shipments of bituminous coal
in Tennessee in 1975

(tons $\times 10^6$)

Total production	8,206
Shipments	8,061
Rail, 58.7%	
Truck, 32.5%	
Water, 8.8%	
Nonmarketed production	145
Mine-mouth facilities, 27.6%	
Other, 72.4%	
Receipts	26,633
Electric utilities, 92.6%	
Coke and gas plants, 0.6%	
Retail dealers, 0.8%	
Others, 6.0%	

There are no natural gas processing plants located in Tennessee.

Electricity. There are 28 hydro plants and 12 fossil fuel plants in the state, most of the latter being coal-fired. Only 1% of the total generating capacity is investor-owned, TVA being the dominant producer of electricity. Approximately 85% of the capacity is from conventional steam plants and 15% from hydro plants. Per capita generation of electricity is 45% higher than the national average.

THE DEMAND FOR ENERGY

The fuel mix of each sector as well as its total Btu usage is shown in Table VII. The utilities are the largest energy users, followed by the transportation sector. Petroleum supplies 36% of the state's energy needs, and coal 34%. The usage of coal in Tennessee distinguishes it somewhat from most southern states, as will be shown as each sector is examined individually.

Residential. Tennessee has more mobile home and single-family housing units than the national average, with relatively less multiple-unit housing. Electricity is the primary means of space and water heating, as well as cooking. Table VIII indicates the fuel usage of this sector relative to the region and the nation as well as the equivalent Btu fuel prices paid. Tennessee residents use little oil and natural gas relative to other states in the region and relative to the nation as a whole. Electricity usage per capita, however, is 51% higher than the regional average, and 95% higher than the national average. Electricity prices are 36% cheaper in Tennessee than in other states, which may explain this unusually high rate of dependence. Natural gas prices are 24% lower than the national

Table VII. Fuel mix by sector in Tennessee in 1974

(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	4.0	39.4	56.6			159.2
Industrial	24.9	9.5	65.6			234.6
Electric utilities	77.2	0.5	0.0	22.3	0.0	459.5
Transportation		93.5	6.5			377.5
Total	34.0	35.9	21.8	8.3	0.0	1232.1

Table VIII. Fuel use by the residential sector in Tennessee in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	0.68	0.23	2.92	1.13
Natural gas	0.72	0.45	1.26	0.76
Electricity	1.51	1.95	6.06	0.64
Kerosene	1.30	2.09	3.24	1.11

average. Fuel oil prices are a little higher in Tennessee than in other states. As in most southern states kerosene and LPG usage are higher than average.

Commercial. Approximately 60% of the state's employees are engaged in commercial activities. The fuel mix of this sector, equivalent Btu fuel prices paid, and fuel usage per commercial employee are shown in Table IX. The commercial sector, like the residential sector, is primarily reliant upon natural gas. Natural gas and coal are used in atypical proportions in the commercial sector. Coal usage is 76% greater than normal. Electricity prices are 17% lower and natural gas prices 17% lower than the national average. On a per employee basis, oil, gas, and electricity are each relatively underutilized. Coal usage per worker, however, is 21% greater in Tennessee than in other states. Electricity usage per commercial employee is 49% less.

Manufacturing. Approximately 39% of the state's employees are in the industrial sector, 85% of these being engaged in manufacturing activities. Table X indicates energy-intensiveness indices for each two-digit SIC in the state in 1974. Fuel oil usage is 71% less, gas usage 18% less, but coal and electricity usage per employee over twice

Table IX. Fuel use by the commercial sector in Tennessee in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	7.1	1.76			7.2	1.21
Oil	28.5	0.73	2.92	1.13	28.8	0.50
Gas	48.0	1.38	1.10	0.83	48.7	0.95
Electricity	16.4	0.74	7.65	0.83	16.6	0.51

Table X. Energy-intensiveness indices of manufacturing in Tennessee in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.39	0.03	1.32	1.15	0.91
21	0.54	0.00	3.29	0.47	1.11
22	0.28	0.75	1.14	0.87	0.74
23	0.08	0.09	1.08	0.99	0.88
24	0.08	3.03	0.79	0.57	0.45
25	0.43	0.05	2.99	0.95	1.63
26	0.37	0.45	1.53	1.54	1.02
27	0.36	0.00	1.76	1.15	1.15
28	0.21	4.11	0.60	2.45	1.22
29	0.39	0.00	0.11	0.19	0.21
30	0.51	0.40	2.01	1.22	1.20
31	0.29	0.77	1.32	1.30	0.64
32	0.48	1.60	0.99	1.38	1.04
33	0.09	1.44	0.70	3.51	1.16
34	0.26	1.90	0.71	0.88	0.78
35	0.33	0.10	0.71	1.24	0.98
36	0.16	0.00	2.22	1.89	1.73
37	0.24	0.00	0.76	0.94	0.63
38	0.53	0.00	3.12	1.04	0.75
39	0.06	5.71	1.18	1.19	1.35
Average	0.29	2.89	0.82	2.03	1.09

as great as the national average. The chemicals and lumber industries use very large amounts of coal per worker relative to the average for these industries. Natural gas usage is particularly high in the tobacco, furniture, and instruments industries. Electricity usage is unusually large in the manufacturing of primary metals. Overall energy usage per worker is greatest in the manufacture of electrical equipment and furniture. It is lowest in petroleum refining and lumber industries. Despite the large amounts of coal and electricity usage per worker, overall energy usage per worker is only 9% greater in Tennessee than in other states.

Table XI indicates the fuel mix of the sector, equivalent Btu fuel prices paid, and fuel usage per worker. The sector is primarily reliant upon natural gas, but its coal and electricity usage are what distinguish the state's manufacturing sector. Electricity prices are 34% lower than the national average, with average fuel prices being 5% less.

Table XI. Fuel use by the manufacturing sector in Tennessee in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	24.9	2.66	0.96	1.11	51.2	2.79
Oil	3.4	0.27	1.88	0.98	7.1	0.28
Gas	37.1	0.76	0.61	0.91	76.2	0.79
Electricity	29.4	1.87	2.68	0.66	60.4	1.96
Coke	0.3	0.09	2.17	1.42	0.5	0.00
Total	95.1		1.37	0.95	205.6	1.05

Electric Utilities. Table XII indicates the fuel mix, equivalent Btu fuel prices paid, and fuel usage per capita of the electric utilities in Tennessee in 1975. As previously noted, this sector is most reliant upon coal, 74% more so than utilities in other states. There is no electrical generation from natural gas. The conversion mandate of the National Energy Plan would not, therefore, present any particular problems to Tennessee utilities. The overall cost of generating a kilowatt-hour of electricity is 16% less than the national average. On a per capita basis, coal and hydro usage are both twice as much as is typical of this sector. Per capita electrical generation is 45% greater than the average.

Table XII. Fuel use by the electric utility sector in Tennessee in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	77.3	1.74	0.88	1.02	10,072	2.52
Oil	1.1	0.07	2.14	1.07	140	0.10
Gas	0.0					
Hydropower	21.6	1.38			2,820	2.00
Nuclear	0.0					
Total	100.0		0.90	0.84	13,032	1.45

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APPENDIX S
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Texas is the largest state in the region with 20% of its population. It is a key producer of oil, natural gas, and natural gas liquids. Table I shows the total energy production and reserves in the state in 1975.

Table I. Energy production and reserves in Texas in 1975
(Btu $\times 10^{12}$)

Energy Input	Production	Proved reserves	Reserve/production ratio
Crude oil	7,087	58,464	8.3
Natural gas	8,182	77,643	9.5
Natural gas liquids	1,320	10,729	8.1
Coal	145	43,189	297.4
Hydropower	7	16	2.4
Total energy	16,741	190,041	11.4

There are 7 counties engaged in the hydro generation of electricity. Though currently there are no nuclear facilities in the state, Texas Utilities Service has the Commanche Peak Steam Electric Station scheduled for 1982 in Glen Rose. Gulf State Utilities has the Blue Hills plant scheduled for commercial operation in 1991 in Jasper. Houston Lighting and Power has the Allens Creek plant scheduled in Wallis in 1985 and the South Texas plant in Matagorda County for 1982.

Per capita income is 7% higher than the regional average and there are 30% fewer mean heating degree days. In terms of total per capita energy usage, Texas is ranked 3rd in the nation (it was ranked 4th in 1972). The energy usage of each sector is shown in Table II. Table III compares the energy utilization patterns of the state with those of the nation. The industrial sector is the largest energy user and it is primarily dependent upon natural gas, as is the state as a whole. Relative to the nation, coal usage per capita is 84% less. Oil usage is 40% greater than the average, however, and natural gas usage almost 4 times the national average. Overall, energy usage is 79% higher in Texas than in any other state (on a per capita basis). Despite this large rate of energy consumption, Texas exports 52% of all energy it produces.

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. Natural gas production first began in 1889, but did not peak until 1972. Average annual production has been increasing over time, such that only 24% of the proven recoverable resource base remains.

Table II. Per capita energy use in Texas in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		18.07	30.33			48.40
Industrial	3.50	81.49	230.01			314.98
Electric utilities	6.31	5.38	113.30	1.45		126.43
Transportation		114.75	7.97			122.73
Other		1.36				1.36
Total	9.80	221.04	381.61	1.45		613.90

Table III. Ratio of 1974 per capita energy use in Texas

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial		0.63	0.85			0.74
Industrial	0.18	2.91	4.85			3.31
Electric utilities	0.16	0.33	6.82	0.09		1.34
Transportation		1.37	2.46			1.41
Other		1.17				1.17
Total	0.16	1.40	3.71	0.09		1.79

Fig. 1. Texas gas production.

The bulk of these reserves were discovered prior to 1950, and few new discoveries have been forthcoming over the past five years. If production continues at the 1976 rate and no new discoveries are made, the state could exhaust its natural gas reserves by 1994. This is contingent upon some extensions and revisions occurring during the next twenty-five years and adequate price incentives for producers to develop this natural gas.

Table IV indicates the interstate shipments of natural gas in the state in 1975. Most of the gas is shipped to Oklahoma and Louisiana and then on to points northeast. In 1975 Texas exported 41% of the gas it produced. Natural gas is the second most important mineral product in the state in terms of value.

Table IV. Interstate shipments of natural gas
in Texas in 1975

	Amount (ft ³ × 10 ⁹)
Marketed production	7485.8
Receipts	0.0
Shipments	3077.9
Oklahoma, 37.9%	
Louisiana, 27.5%	
New Mexico, 17.2%	
Arkansas, 17.1%	
Mexico, 0.2%	
Retained for consumption	4407.9
Consumption	4379.9
Δ Underground storage	+3.5

Crude Oil. Currently 83% of the 254 counties in the state have either oil or gas production. Approximately 26% of the total land area has proven productive or is under exploration lease. Crude petroleum is the most valued mineral product of the state. Production began in 1889 and peaked in 1972. The production history of oil in the state is charted in Figure 2. The average annual rate of production has increased over time, as has the depletion rate. The average depletion rate exceeds that of the nation as a whole. Only 19% of the proven recoverable resource base remains. By adding the indicated reserves and probable extensions and revisions to the proven reserves, it appears that Texas could deplete its domestic oil resources by 1989. This assumes there will be no new discoveries and production rates continue at 1976 levels.

A significant portion of Texas crude is shipped to other states for refining. Table V shows the interstate shipments of crude oil in the state in 1975. Note that Texas is now a net importer of crude oil.

Fig. 2. Texas oil production.

Table V. Interstate shipments of crude oil in Texas in 1975

	Amount (bbl x 10 ³)
Production	1,221,929
Receipts	368,392
Foreign sources, 83.8%	
Louisiana, 5.8%	
Florida, 3.5%	
New Mexico, 2.9%	
Mississippi, 2.7%	
Utah, 0.9%	
Colorado, 0.4%	
Alaska, 0.1%	
Shipments	353,289
Illinois, 32.5%	
Indiana, 16.9%	
Ohio, 16.7%	
Oklahoma, 11.4%	
Missouri, 7.4%	
Kansas, 5.9%	
Pennsylvania, 3.3%	
New Jersey, 2.4%	
Arkansas, 1.4%	
Kentucky & Tennessee, 1.4%	
New York, 0.4%	
Minnesota & Wisconsin, 0.3%	
Retained for consumption	1,237,032
Change in stocks	1,910
Refinery loss	155
Crude runs to stills	1,210,366

Approximately one-fourth of all the crude processed in the state is imported from foreign sources. About 54% of the interstate shipments are via pipeline and 46% by tanker. Intrastate pipeline shipments account for 96% of the total. Of the foreign shipments, 98% are via tanker. Of the total pipeline mileage in the state (53,018) 44% are crude trunk lines, 36% crude gathering lines, and 20% petroleum product lines.

The proposal for a deep water port, Seadock, is now dormant. Exxon has dropped out of the venture, and so far there have been few non-oil company participants. It is felt that Seadock is essential to the economy of Texas, nonetheless, and substantial support for its eventual construction persists.

Coal. There are four active coal mines producing lignite in Freestone, Milam, Harrison, and Titus counties. The Big Brown steam-generating plant in Fairfield, which accounts for half the total lignite consumption in the state, is supplied by a large lignite strip mine in Freestone. There are deposits of bituminous coal in north central Texas in the Fort Worth basin and Brazos River area. The coal has a high sulfur content, however, and thin beds and thick overburdens make mining of these deposits uneconomical at present. Natural graphite is produced in Burnet County.

The state currently imports coal, though coal is expected to play a very substantial role in electrical generation in the future. Utilities in the state have been ordered to convert, and coal reserves are being examined with more scrutiny. A pilot plant to test the commercial and technical feasibility of coal gasification and liquefaction is to be constructed in Baytown in the immediate future. Longwall mining techniques which recover more coal than conventional mining are also being analyzed closely. Longwall mining employs self-advancing jacks to support the overburden while a continuous mining machine cuts away most of the coal seam. As the supports advance behind the cutting machine, the overburden subsides sealing the mined-out area and reducing acid mine drainage. The longwall technique has the advantage of controlled subsidence and of protecting the miner under the moving braces.

Current shipments of coal in the state were presented in Appendix A. The distribution of coal receipts in Texas are shown in Table VI below.

Table VI. Shipments of bituminous coal
in Texas in 1975
(tons $\times 10^6$)

Production	11,002
Intrastate shipments	9,146
Receipts	
Electric utilities, 73.3%	
Coke and gas plants, 7.9%	
Other, 18.8%	

Uranium. Texas and Florida are the only states in the South with uranium reserves. Two large uranium milling companies are located in Falls City. Reserve estimates indicate 58.6 million pounds of recoverable uranium in the state.

Geopressure. One alternative energy source for the state is the development of natural gas from geopressure zones. Total usable resources are estimated at about 250 quadrillion Btus. The well in Brazoria County (funded by the Department of Energy) is now being drilled. Expected flow is to be such that by 1982 there will be a geopressure electrical and gas plant operational with a capacity of 104 megawatts. Ultimate production from the fairway underlying Brazoria County may be 1600 megawatts by 2000.

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. There are 46 refineries in the state with a capacity of over 4 million barrels of oil per stream day. Texas is a net exporter of most petroleum products, with product lines located primarily along the Gulf Coast, Permian Basin, and Texas Panhandle. Refined products are sent via pipeline to major consuming areas in the northeast and midwest.

There are 357 natural gas processing plants in the state with a capacity of 29 billion cubic feet of gas per day. In 1975 the state produced 524 billion barrels of raw NGL, propane, ethane, etc. Another product, helium, has been extracted from natural gas deposits near Amarillo and has proven effective in permitting the proper functioning of technical instruments in zero-gravity conditions. This usage of natural gas is particularly important for the aerospace program.

Electricity. There are 21 hydro plants in the state and 160 fossil fuel plants, most of the latter being gas-fired. Approximately 83% of the total generating capacity is investor-owned. Currently 98% of the generation is from conventional steam plants, 1% from hydro plants, and 1% from internal combustion. Per capita electrical generation is 36% greater than the national average.

The majority of the region's industrial generation of electricity is in Texas. The conversion mandate of the National Energy Plan could have substantial impacts on the gas-fired utilities of the state. The shift toward coal-fired plants has already begun.

THE DEMAND FOR ENERGY

The fuel mix and total Btu usage of each sector is shown in Table VII. The state relies upon natural gas for over 62% of its energy needs. The residential, commercial, industrial, and electric utility sectors each are primarily dependent upon natural gas. The residential-commercial sector consumes only 8% of the total energy.

Residential. Texas has 16% more single-family housing units than is typical; 19% fewer mobile homes. Natural gas is the primary fuel for space and water heating, as well as cooking. There are 80% more air-conditioners per household in Texas than in the average state in the

Table VII. Fuel mix by sector in Texas in 1974
(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	0.0	37.3	62.7			581.6
Industrial	1.1	25.9	73.0			3785.1
Electric utilities	5.0	4.3	89.6	1.1		1519.3
Transportation		93.5	6.5			1474.8
Total	1.6	36.0	62.2	0.2		7377.2

nation. Table VIII indicates the fuel usage of the state relative to the region and the nation as a whole as well as the equivalent Btu fuel prices paid. While per capita natural gas usage is 31% higher than the regional average, it is 18% less than the national average. Electricity usage per capita, however, is 19% higher. Kerosene usage is over twice the amount utilized nationally. Natural gas prices are 11% lower in Texas than elsewhere, and electricity prices 15% lower.

Table VIII. Fuel use by the residential sector in Texas in 1975

Fuel	Use relative to the South	Use relative to the United States	Price (\$/10 ⁶ Btu)	Ratio
Distillate oil	0.62	0.21	2.54	0.99
Kerosene	1.39	2.23	2.75	0.94
Natural gas	1.31	0.82	1.49	0.89
Electricity	0.93	1.19	8.00	0.85

Commercial. Approximately 66% of the state's employees are engaged in commercial activities. Table IX indicates the fuel mix, equivalent Btu fuel prices paid, and fuel usage per commercial employee in Texas in 1975. The sector is equally reliant upon natural gas, petroleum, and electricity. Electricity prices are 24% lower than in other states and natural gas prices 22% lower. On a per employee basis, both oil and gas are underutilized. Electricity usage per commercial employee, however, is 28% greater than the average for this sector.

Manufacturing. The industrial sector employs 29% of the state. Of these employees, 66% are engaged in manufacturing activities. Table X indicates the energy-intensiveness of each two-digit in the state in 1974.

Table IX. Fuel use by the commercial sector in Texas in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Petroleum	33.2	0.85	2.54	0.99	41.2	0.72
Natural gas	32.9	0.95	1.03	0.78	40.9	0.80
Electricity	33.9	1.52	7.02	0.76	42.1	1.28

Table X. Energy-intensiveness indices of manufacturing in Texas in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.12		1.26	1.14	0.86
22	0.20		1.84	0.98	0.96
23	0.43		1.22	1.09	0.88
24	0.16		0.41	0.69	0.57
25	0.19		6.13	0.74	0.83
26	0.49		2.60	1.28	1.20
27	0.00		2.35	1.07	1.14
28	0.13		7.32	2.12	4.68
29	0.14		3.24	1.26	2.66
30	0.41		1.23	1.15	0.88
32	0.33		2.43	1.19	1.47
33	0.26		3.78	2.20	2.25
34	0.31		1.14	1.11	1.00
35	0.01		1.63	1.30	1.19
36	0.04		0.41	0.86	0.60
37	0.20		1.02	0.94	0.84
38	0.04		0.26	0.72	0.19
39	0.00		1.08	0.31	0.49
Average	0.25		6.47	1.79	3.67

On a per employee basis, oil usage is 75% less than average. Natural gas is 6.5 times the national average and electricity usage 79% higher. Overall energy usage per worker is 3.7 times as much as is typical of the manufacturing sector.

Not surprisingly, the chemicals industry is the largest energy user in the state, with energy per worker being 4.7 times as great as the average. Petroleum refining and primary metal manufacturing also utilizes relatively large quantities of energy per worker. The greatest natural gas usage per worker is in the furniture industry, and the greatest electricity usage in primary metals and chemicals. Per employee energy usage is lowest in the lumber and instruments industries.

Table XI indicates the fuel mix, equivalent Btu fuel prices, and fuel usage per worker in the manufacturing sector in Texas in 1974. The sector is most reliant upon natural gas, 77% more so than is the case elsewhere. Electricity prices are 27% less, natural gas prices 19% less, and fuel oil prices 20% less. Average fuel prices paid are 48% lower in Texas than in other states. On a per employee basis, coke and oil usage are extremely low.

Table XI. Fuel use by the manufacturing sector in Texas in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal						
Oil	0.9	0.07	1.54	0.80	6.1	0.24
Gas	86.5	1.77	0.54	0.81	597.5	6.22
Electricity	7.7	0.49	2.95	0.73	53.0	1.72
Coke	0.5	0.18	1.84	1.20	3.5	0.03
Total	95.6		0.76	0.52	690.4	3.52

Electric Utilities. Table XII indicates the fuel mix, equivalent Btu fuel prices, and fuel usage per capita of the electric utilities in Texas in 1975. The utilities generate over 90% of the electricity from gas-fired plants. Both coal and oil are relatively underutilized in electrical generation. Natural gas prices paid are approximately the same as those prevailing elsewhere (the intrastate market is not regulated). Fuel oil prices are 14% less and coal prices 72% less. Overall the cost of generating a kilowatt-hour of electricity is 33% less than the average. Natural gas usage per capita is almost 8 times as much as elsewhere. Per capita electrical generation is 36% higher.

Table XII. Fuel use by the electric utility sector in Texas in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	7.7	0.17	0.24	0.28	933	0.23
Oil	0.7	0.05	1.71	0.86	86	0.06
Gas	90.2	5.77	0.75	1.01	10,893	7.45
Hydropower	1.3	0.08			157	0.11
Total	100.0		0.72	0.67	12,076	1.34

APPENDIX T
VIRGINIA

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Virginia is a fairly populous state with 8% of the region's population. Its comparative advantage is in the production of coal, as shown in Table I. Most of this coal is located in the southwestern part of the state on the eastern edge of the Appalachian coal field.

Table I. Energy production and reserves in Virginia in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Natural gas	7	52	7.1
Coal	936	96,211	102.8
Hydropower	4	25	5.8
Nuclear	96	158	1.7
Total energy	1,043	96,446	92.5

There are 8 counties in the state with hydro generation of electricity. There is one nuclear facility in Gravel Neck operated by Virginia Electric and Power Company. Two additional units are scheduled for commercial operation in 1987. The 4-unit North Anna Power Station is scheduled for operation in Mineral in 1978.

Per capita income is the highest in the South. The state, however, has 31% more mean heating degree days. In terms of its per capita energy consumption, the state is ranked 37th in the United States (relative to 39th in 1972). Per capita energy usage of each sector and fuel is shown in Table II. Table III compares these energy utilization patterns with those of the United States.

The transportation sector is the largest energy user in the state, and petroleum products are the most important source of energy. In 1974 petroleum supplied almost two-thirds of the total energy needs of the state. All sectors are primarily reliant upon petroleum as the major fuel source. All sectors relatively underutilize energy, with the exception of the transportation sector. Coal usage per capita is 39% less than average, natural gas usage 70% less, and petroleum usage 4% more. Nuclear energy is 2.3 times as important in Virginia as in other states. Overall, the state consumes 28% less energy per capita than the average. Per capita energy imports are about 50% higher in the state than the national average.

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. Natural gas production in the state began in 1931, but was not recorded until 1949. There are six counties with either oil or

Table II. Per capita energy use in Virginia in 1974

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	2.71	22.71	17.35			42.77
Industrial	12.48	14.58	11.73			38.80
Electric utilities	21.96	35.44	1.00	2.28	12.93	73.61
Transportation		91.85	0.88			92.73
Other	0.04	0.51				0.55
Total	37.15	165.09	30.96	2.28	12.93	248.41

Table III. Ratio of 1974 per capita energy use in Virginia

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	1.92	0.79	0.49			0.65
Industrial	0.64	0.52	0.25			0.41
Electric utilities	0.54	2.15	0.06	0.15	2.26	0.78
Transportation		1.09	0.27			1.06
Other		0.44				0.47
Total	0.61	1.04	0.30	0.15	2.26	0.72

gas production (Buchanan, Dickinson, Lee, Russell, Tazewell, and Wise). Only 4% of the total land area has proven productive or is under exploration lease. Production has been increasing over time, but several new discoveries were made during the last five years to offset this. Approximately 41% of the proven recoverable resource base remains. The annual depletion rate, however, current exceeds that of the region or the nation. If we add the probable extensions and revisions likely to occur during the next twenty-five years, and assume that production rates of 1976 are maintained, Virginia should have natural gas available domestically until 1992. It is currently able to import 95% of its natural gas needs, however. If curtailments continue, Virginia will have to use more of its own gas reserves. The actual curtailments in 1975 are shown in Table IV, which also indicates proposed curtailments in 1976.

The Virginia State Corporation Commission is responsible for adopting a priority scheme for distributing limited gas supplies, based on "end use." In addition to the three intrastate pipeline companies, Commonwealth Natural Gas Company operates a synthetic natural gas plant in Chesapeake with a capacity of 30 million cubic feet per day. Included at the site are loading and storage facilities for LNG. One of the state's large manufacturers, Dan River Mills, was part of the first agreement between a heavily curtailed gas user and a gas producer for supplies to be shipped interstate at intrastate unregulated prices.

The average intrastate price of natural gas on new contracts in the Appalachian area in the summer of 1976 was \$1.134 per mcf versus a national average of \$1.434. The average intrastate price on renegotiated contracts was \$1.202 versus a national average of \$1.633 per mcf.

A primary focus of the Virginia Coal and Energy Commission has been the extraction of methane from underground coal mines for use as a substitute for natural gas. This commission is also involved in assessing prospects for coal gasification and liquefaction in the state.

Figure 1 illustrates the natural gas pipeline network in the state. Table V indicates the total interstate shipments of natural gas in 1975. Most of the natural gas receipts are from North Carolina, and most shipments are to Maryland. The state, of course, acts as an intermediary of natural gas from the Gulf Coast.

Crude Oil. Crude oil production began in 1943 and peaked in 1947. All proven recoverable reserves have now been extracted, and the state's one refinery is dependent upon imports of crude oil. There are no interstate crude oil pipelines. Most intrastate shipments and foreign shipments are via tanker. Table VI indicates the receipts of crude oil in the state in 1975. All the crude oil was imported by tanker from foreign sources. In 1974 there were 2.8 thousand barrels of crude oil produced — enough to supply the requirements of the Amoco refinery about 1 hour and 15 minutes each year. Thus, like most east coast states, Virginia is dependent upon petroleum from Venezuela and the Caribbean Islands.

Table IV. Natural gas curtailments in Virginia: 1975-1976^a

Pipeline company	1974 Consumption delivered (%)	1975 Total volume (ft ³ × 10 ⁹)	Firm (%)	Interruptible (%)	Other (%)	1975 Actual curtailments (%)	1976 Proposed curtailments (%)
Bluefield	0	1,147	0	0	0	11.9	0
Columbia	48	1,126,182	98.5	0	1.5	12.9	27.9
East Tennessee	6	54,322	0	0	0	12.9	35.7
Sherandoah	2	NA					
Transcontinental	22	745,614	96.5	0	3.5	27.7	40.5
Washington Gas	22	103,475					
Total	148,330	2,030,740					

^aVirginia has been determined to be a state "highly impacted" by natural gas shortages by FEA, Mathematica, the American Gas Association, the Federal Power Commission, the Rural Power Association, and the DOC-NGTF.

Source: Federal Power Commission, Bureau of Natural Gas, *The Gas Supplies of Interstate Natural Gas Pipeline Companies: 1975*, Washington, D.C., January, 1977.

Fig. 1. Major natural gas pipelines in Virginia. Source: Division of Industrial Development 1972.

Table V. Interstate shipments of natural gas in Virginia in 1975

	Amount (ft ³ × 10 ⁹)
Marked production	6.7
Receipts	784.1
69.1% from North Carolina	
30.1% from West Virginia	
0.8% from Tennessee	
Shipments	665.5
98.5% to Maryland	
1.5% to Washington	
Retained for consumption	125.3
Consumption	121.3
Δ Underground storage	-1.4

Table VI. Interstate shipments of crude oil in Virginia in 1975

	Amount (bbl × 10 ³)
Production	3
Receipts	15,732
Foreign sources, 100.0%	
Shipments	0
Retained for consumption	15,735
Δ Stocks	-323
Refinery loss	4
Crude runs to stills	16,085

The governor appointed a coordinator of oil-related developments before the U.S. Department of Interior began leasing the east coast's outer continental shelf. The feasibility and desirability of a deep-water port has been under study, resulting in recommendations to encourage any such development. The Virginia Institute of Marine Science was awarded a \$2.8 million grant to conduct oceanographic studies offshore to determine the effects of offshore drilling on the marine environment.

Coal. There are 682 active coal mines in the same six counties that have oil and gas production. It is the most important mineral

product of the state, and is ranked 6th among coal-producing states. In 1975 coal mining employment in the state was over 16,000. The average price per ton of coal was \$21.60 versus a national average price of \$18.75.

Virginia is a net exporter of coal, most of which is shipped to North Carolina via rail. The shipments of bituminous coal in 1975 are shown in Table VII. Coal production is about five times consumption within the state. Key aspects of greater coal use will be extensive underground mining and environmentally responsible strip mining, economical yet environmentally sound methods of burning coal, aggressive development of a commercial coal conversion industry, and the capacity to handle higher volumes of mined coal on the railroad system. (Fifty eight percent of the coal has a sulfur content of less than 1%.)

Table VII. Shipments of bituminous coal in Virginia in 1975
(tons $\times 10^6$)

Total production	35,510
Shipments	35,506
Rail, 85.6%	
Truck, 14.4%	
Nonmarketed production	3
Mine-mouth facilities, 0.0%	
Other, 100.0%	
Receipts	6,561
Electric utilities, 60.8%	
Coke and gas plants, 0.0%	
Retail dealers, 3.2%	
Other, 36.0%	

Coal, oil, and gas producers pay corporate income taxes, property taxes, and severance taxes. The severance tax varies from county to county, but can be as much as 1% of gross receipts. In 1975 the severance tax alone brought \$4 million in tax receipts.

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. Amoco Oil Company operates the only refinery in the state in Yorktown. It has a capacity of 55,000 barrels of oil per stream day. This compares with petroleum product consumption on the order of 389,000 barrels per day. There are 824 miles of product pipeline in the state, owned principally by Plantation and Colonial Pipeline companies.

Because it is situated on the east coast with an excellent harbor and river system, Virginia has been more dependent upon petroleum products that are directly imported to the United States than other more central states. The State Water Control Board has granted a conditional permit to the Hampton Roads Energy Company for the construction of a \$550 million oil refinery near Portsmouth. The company must accept all responsibility and liability for cleaning up oil spills caused by tankers approaching or leaving the refinery's terminal, and 180 days prior to its scheduled opening, an oil-spill clean-up plan must be filed with the Board. This project is awaiting final approval from the U.S. Army Corps of Engineers. When it goes into operation, it will quadruple oil refining capacity.

There are no natural gas processing plants in the state at this time.

Electricity. There is 1 nuclear facility, 23 hydro facilities, and 26 fossil fuel plants in the state. Approximately 97% of the total capacity is investor-owned by Virginia Electric and Power, Appalachian Power, Potomac Electric Power, and Potomac Edison. The remainder was produced by the Army Corps of Engineers at Kerr Reservoir, Virginia Polytechnic Institute, and the state university. The chemical and paper manufacturers which generate their own electricity are not included in this total. Approximately 74% of the generation is from conventional steam plants (primarily oil-fired), 17% from nuclear sources, and 9% from hydro sources.

FEA has ordered the Chesterfield, Portsmouth, and Yorktown stations to convert to coal. EPA has certified these stations if particulate controls are installed. The Yorktown station, however, is still under a county court ruling which requires it to burn oil. This situation has yet to be worked out by FEA.

By late 1979 an \$8.4 million trash-fired steam generating plant will be built at Hampton and is expected to save the city \$300,000 annually in solid waste disposal costs. The 225-ton capacity plant, RECOUP, will burn garbage from the city, NASA's Langley Research Center, Fort Monroce, and the VA hospital. All steam generated will be sold to Langley. The project represents an unprecedented partnership between local government and federal agencies.

The first unit of the VEPCO nuclear plant began operation in December 1972 and the second in May 1973. VEPCO plans to have more than 7,200 megawatts of nuclear-powered generating capacity on-line by 1986. Babcock and Wilcox is the only nuclear fuel cycle-related processor in the state, fabricating uranium fuel in Lynchburg. No reprocessing plant has been licensed and spent fuel is being stored at the reactor sites.

Annual growth rates of electricity usage in the state have surpassed those of the nation over the past ten years. Net electricity imports were required in 1974 to meet the increasing demand and offset transmission losses (3-8% of final sales). VEPCO imports electricity from its mine-mouth generating plant at Mt. Storm, West Virginia.

ELECTRIC POWER UTILITIES SERVING VIRGINIA

Fig. 2. Electric power utilities serving Virginia. Source: Final report of the Electricity Costs Commission, July 1, 1975.

THE DEMAND FOR ENERGY

Table VIII summarizes the fuel mix of each sector and its total Btu usage. The largest energy user is the transportation sector, followed by the utilities and residential-commercial sectors. Petroleum supplies 66% of the energy needs, coal 15%, and natural gas 13%. Per capita coal usage has declined since 1969, both that of electric utilities and industries.

Table VIII. Fuel mix by sector in Virginia in 1974
(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	6.3	53.1	40.6			210.0
Industrial	32.2	37.6	30.2			190.5
Electric utilities	29.8	48.1	1.4	3.1	17.6	361.4
Transportation		99.1	0.9			455.3
Total	15.0	66.4	12.5	0.9	5.2	1219.8

Residential. Table IX indicates the fuel mix, equivalent Btu fuel prices paid, and fuel usage per capita of the residential sector in 1975. Also shown is how this usage compares to national energy patterns. Fuel oil is the primary fuel utilized for space heating, and electricity is the main source for water heating and cooking.

Table IX. Fuel use by the residential sector in Virginia in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Petroleum	36.5	1.30	2.63	1.02	12.4	0.94
Natural gas	29.9	0.59	2.20	1.31	10.2	0.43
Electricity	31.2	1.55	10.12	1.00	10.6	1.13
Coal	2.4	3.00		0.98	0.8	2.11

The sector relies primarily upon petroleum products. Its fuel mix is atypical in terms of low reliance upon natural gas, and heavy reliance upon coal. The low rate of natural gas usage may be due to the fact that natural gas prices are 31% higher in Virginia than other states. All

other fuel prices are approximately the same. On a per capita basis, Virginia underutilizes both petroleum products and natural gas, especially the latter. Coal usage is over twice as great as is typical, however, and electricity usage is 13% higher.

The Virginia Winterization Training Program was established in February 1976 to provide training to local community action agencies in the prevention of cold air infiltration, installation of thermal insulation and storm windows, etc. These agencies will winterize homes of low income and elderly people in the state. Grants of up to \$200 are provided for the purchase of necessary materials. Based upon the availability of federal funds, it was anticipated that 1500 homes would be winterized. Reductions in heat loss are expected to be in the 25-30% range with fuel savings of \$100 to \$150 per home annually.

Commercial. Approximately 63% of the state's employees are engaged in commercial activities. The state has 11% more government employees than most southern states. Some 10% of the electricity sales in the state are to public authorities, primarily military installations. Table X indicates the fuel mix of this sector, equivalent Btu fuel prices paid, and fuel usage per commercial employee.

Table X. Fuel use by the commercial sector in Virginia in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	1.9	2.71			1.8	2.06
Petroleum	24.3	0.74	2.63	1.02	23.7	0.56
Natural gas	29.5	0.73	1.68	1.27	28.5	0.56
Electricity	44.3	1.72	8.77	0.95	43.2	1.32

The sector is most reliant upon electricity, 72% more so than commercial sectors elsewhere. Electricity prices are 5% less in Virginia than other states, while natural gas prices are 27% higher. On a per employee basis, coal usage is twice as great, electricity usage 32% higher, and petroleum and natural gas usage 44% less.

About three dozen buildings have been outfitted for solar energy systems. One example is the Terraset Elementary School in Reston. Plans call for 5-7000 square feet of evacuated tubular glass collectors, three 10,000-gallon storage tanks, and a 40-ton solar-driven air conditioner. The building is set almost completely underground. The use of insulation and sun-shielding properties of the earth is expected to reduce energy requirements to about half those of conventional structures of comparable size. Four contracting firms are participating in a HUD-sponsored program to install solar demonstration units in new and existing residences.

Manufacturing. Approximately 31% of the state's employees are in the industrial sector, and 71% of these employees are engaged in manufacturing activities. Table XI indicates energy-intensiveness indices for each two-digit SIC in the state in 1974. Oil usage per employee is 69% less than the national average, natural gas usage is 66% less, and electricity usage 28% less. Coal usage per worker, however, is 2.5 times as great as is typical. Overall, the state uses 10% less energy per worker than do manufacturing sectors in other states.

Table XI. Energy-intensiveness indices of manufacturing in Virginia in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.96	0.03	0.39	0.83	0.58
21	1.96	0.08	1.60	1.67	1.24
22	0.92	4.51	0.86	0.83	1.12
23	1.69	1.74	1.64	0.96	1.18
24	1.13	6.79	0.70	0.85	0.87
25	1.62	5.85	0.38	1.23	1.01
26	2.00	4.19	0.52	1.00	1.73
27	1.72	0.06	0.88	1.00	0.72
28	3.56	2.62	0.18	0.52	0.87
30	7.83	1.53	1.28	1.11	2.18
31	0.46	1.80	0.00	1.46	1.31
32	1.26	1.28	0.72	0.86	0.96
33	0.29	0.98	0.43	0.44	0.68
34	0.41	0.00	0.36	0.72	0.54
35	0.58	2.55	1.39	1.16	1.71
36	1.32	0.00	0.71	1.27	1.00
37	3.82	0.52	0.09	0.82	0.82
38	1.99	0.00	2.57	5.46	3.71
39	0.58	4.99	0.00	0.92	1.03
Average	0.31	2.53	0.34	0.72	0.90

Oil usage per worker is exceptionally high in rubber-plastics, transportation equipment, and chemicals. Coal usage is particularly high in lumber, furniture, paper, and textile manufacturing. Natural gas and electricity usage are high in the instruments industry. The

largest energy user per worker is rubber-plastics, and the smallest are fabricated metals and food industries.

Table XII indicates the fuel mix of the sector, equivalent Btu fuel prices paid, and fuel usage per worker in 1974. The sector is most reliant upon petroleum products — 2.4 times more so than is typically the case. Coal prices are 36% higher, electricity prices 27% higher, natural gas prices 19% higher, and fuel oil prices 9% cheaper than in other states. Overall the average fuel cost to the sector is 23% higher in Virginia than elsewhere. On a per employee basis, the sector uses 13% less energy than the national average. Coal and petroleum usage, however, are more than twice as great. Natural gas usage is 67% less and electricity usage 30% less.

Table XII. Fuel use by the manufacturing sector in Virginia in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	26.5	2.83	1.18	1.36	45.0	2.45
Oil	30.7	2.37	1.74	0.91	52.2	2.06
Gas	18.8	0.38	0.79	1.19	32.0	0.33
Electricity	12.7	0.81	5.12	1.27	21.6	0.70
Coke	0.9	0.30	2.51	1.63	1.5	0.01
Total	89.6		1.79	1.23	170.1	0.87

Electric Utilities. Table XIII indicates the fuel mix of the utilities, the equivalent Btu fuel prices they pay, and fuel usage per capita in 1975. The sector is primarily reliant upon petroleum products — 2.9 times more so than is typically the case. Coal usage is relatively low, but coal prices are currently 40% higher in Virginia than other states. Natural gas prices are 39% higher, while petroleum prices are 7% less. Overall, the average cost of generating a kilowatt hour of electricity in the state is 51% higher than the national average. On a per capita basis, the sector utilizes coal only half as much as is typical, petroleum 2.3 times more than is typical. There is also unusually high reliance upon nuclear energy in the state. Per capita electrical generation is 21% lower than the national average.

ENVIRONMENTAL ISSUES

Virginia is seeking a balance between energy supply for a growing population and conservation of natural resources and protection of environmental quality. Examples of conflicts between these needs are the controversies surrounding the proposed Hampton Roads oil refinery and the

hydroelectric installation on the New River in Grayson County. From 1962 to 1976 the Appalachian Power Company sought approval to construct an 1800 megawatt hydroelectric plant. Approved by the Federal Power Commission, the project was blocked in Congress when the New River was included in the National Scenic Rivers System at the urging of environmentalists. Still under consideration are the controversial pumped storage projects in Bath, Davis, and Randolph County.

Table XIII. Fuel use by the electric utility sector in Virginia in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	27.8	0.63	1.21	1.40	1978	0.49
Oil	43.0	2.86	1.87	0.93	3059	2.26
Gas	0.1	0.01	1.04	1.39	7	0.00
Hydropower	3.6	0.23			256	0.18
Nuclear	25.4	2.83			1806	2.24
Total	100.0		1.62	1.51	7106	0.79

Air quality is mixed. Virginia easily meets sulfur-dioxide standards, but the Washington, Richmond, and Valley of Virginia area do not meet particulate standards. The entire state exceeds standards for oxidants. Water quality is good throughout the state, except for the highly urbanized east. Major portions of the James, York, Rappahannock, and Potomac Rivers do not meet water quality standards.

In 1975 the Virginia General Assembly formed the Virginia Coastal Zone Study Commission to consider developments on the outer continental shelf. The Senate resolved that "exploration and development of oil and gas resources of the OCS adjacent to Virginia's coast should be encouraged and promoted, provided that such activities are consistent with the requirements of applicable environmental safeguards and conducted so as to protect, insofar as possible, onshore social, economic, and environmental conditions of the coastal area."

The Virginia Energy Resource Advisory Commission was formed in 1975 to develop a state energy conservation program. The governor has already indicated his corporation in complying with all conservation requirements of the states as detailed in the Energy Policy and Conservation Act. Ten advisory groups have been enlisted in the formulation of an Energy Management and Conservation Plan with representatives from trade associations, government agencies, and educational institutions. Virginia is one of thirteen states with an administratively-adopted state-wide building code.

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West Virginia is a relatively small state with only 3% of the region's population, but is well endowed in terms of energy resources. Table I shows the energy production and reserves in West Virginia in 1975. The state's comparative advantage is, of course, in the production of coal. There are 6 counties generating electricity from hydro sources. There are no nuclear facilities in the state, and none are scheduled or planned.

Table I. Energy production and reserves in West Virginia in 1975
(Btu $\times 10^{12}$)

Energy input	Production	Proved reserves	Reserve/production ratio
Crude oil	14	182	12.7
Natural gas	169	2,526	15.0
Natural gas liquids	23	333	14.4
Coal	2,929	1,061,007	362.3
Hydropower	2	3	1.9
Total energy	3,137	1,064,051	339.2

Per capita income is 4% less than the regional average, but there are 69% more mean heating degree days. In terms of its per capita energy consumption, West Virginia is ranked 5th in the nation (3rd in the region). Table II indicates the per capita energy usage of each sector by fuel in 1974. Table III compares these patterns of energy utilization with those in the United States as a whole.

The largest energy user per capita is the electric utility sector, which is almost completely reliant upon coal. The industrial sector also uses coal predominantly, while the residential-commercial sector depends most upon natural gas. Coal currently supplies about two-thirds of the total energy requirements of the state. Relative to the nation, coal usage per capita in West Virginia is 7.4 times higher! Overall the state uses twice as much energy per capita as any other state. Despite this large rate of consumption, West Virginia exports 62% of all the energy it produces.

THE SUPPLY OF ENERGY: Energy Inputs

Natural Gas. Currently 48 of the 55 counties in the state have oil or gas reserves. Approximately 77% of the total land area has been proven productive or is under exploration lease. Natural gas is the second most important mineral product in the state. Production began in 1885, and

Table II. Per capita energy use in West Virginia in 1974
(Btu $\times 10^6$)

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	4.93	7.68	44.84			57.46
Industrial	141.65	41.59	63.12			246.36
Electric utilities	309.36	4.43	0.22	2.47		316.48
Transportation		67.66	8.97			76.63
Other		0.28				0.28
Total	455.94	121.64	117.15	2.47		697.20

Table III. Ratio of 1974 per capita energy use in West Virginia

Sector	Coal	Oil	Gas	Hydropower	Nuclear	Total
Residential-commercial	3.50	0.27	1.26			0.87
Industrial	7.25	1.49	1.33			2.59
Electric utilities	7.68	0.27	0.01	0.16		3.35
Transportation		0.81	2.77			0.88
Other		0.24				0.24
Total	7.44	0.77	1.14	0.16		2.03

has been declining since 1971. The production history of natural gas in the state is charted in Figure 1. Most of the reserves were discovered prior to 1950, and there have been very few new discoveries during the past five years. The average annual depletion rate, however, is only one-third the national rate. Of the proven recoverable reserve base, 14% remains. If we add the probable extensions and revisions likely to occur over the next twenty-five years, given adequate price incentives, it appears that West Virginia will have natural gas until 2000. This is contingent upon whether 1976 production rates are maintained.

Despite the state's role as the largest natural gas producer east of the Mississippi River, it is expanding efforts to increase production by exploration, research into new techniques of recovery, and legislated incentives. Columbia Gas plans to drill 32 new developmental wells and 8 new exploratory wells this year. Columbia Gas and ERDA are conducting parallel programs to develop technology for freeing gas in the Devonian shale and tight sandstone formations.

EPA added water pollution controls for oil and gas well development recently. During the drilling phase, sediment control measures similar to those in the current surface mining regulations would be required. Guidelines for construction of access roads, sedimentation ponds, and drilling ponds are provided to control surface runoff, drilling fluids, intercepted liquids, and fracture media. The Oil and Gas Conservation Commission regulates the spacing of deep drilled oil and gas wells and restricts the number of wells drilled so that optimum production per well is assured. Congressman Mollohan has introduced federal legislation exempting small natural gas stripper wells from federal regulation as a means of increasing production.

Natural gas shortages have been increasing over the past two years. Curtailments have wreaked havoc with industry and consumers as well. These shortages, of course, are not equally distributed across the country. Table IV indicates the actual curtailments of natural gas in West Virginia in 1975 and the proposed curtailments of 1976.

Table V indicates the total interstate shipments of natural gas in the state in 1975. Imports currently satisfy 23% of the natural gas requirements of the state. Most receipts are from Kentucky, and most shipments to Pennsylvania. The major interstate pipeline companies serving the state are Columbia Gas Transmission Corporation, Texas Eastern Transmission Corporation, and Consolidated Gas Supply Corporation.

Crude Oil. Crude oil production began in 1860 and peaked in 1900. The production history of the state is charted in Figure 2. Average annual production has been declining over the past five years, and the annual depletion rate is less than the national average. Only 6% of the proven recoverable resource base remains, however. Adding the indicated reserves, and probable extensions and revisions likely to be forthcoming over the next twenty-five years, it appears that West Virginia will have crude oil until 1991.

Fig. 1. West Virginia gas production.

Table IV. Natural gas curtailments in West Virginia: 1975-1976^a

Pipeline company	1974 Consumption delivered (%)	1975 Total volume (ft ³ × 10 ⁶)	Firm (%)	Interruptible (%)	Other (%)	1975 Actual curtailments (%)	1976 Proposed curtailments (%)
Bluefield	1	1,147	0	0	0	11.9	0
Carnegie	0	12,110	64.8	32.8	2.4		
Columbia	83	1,126,182	98.5	0	1.5	12.9	27.9
Consolidated	2	627,211	96.0	0	4.0	1.3	5.8
Equitable	6	89,428	91.0	0.1	8.9		
Inland	1	12,118	0	0	0		
Mountain Gas	1	275	0	0	0		
Shenandoah	3	NA					
Tenneco	4	NA					
Total	101,950	1,868,471					

^aWest Virginia has been determined to be a state "highly impacted" by natural gas shortages by FEA, Mathematica, and the Rural Power Association.

Source: Federal Power Commission, Bureau of Natural Gas, *The Gas Supplies of Interstate Natural Gas Pipeline Companies: 1975*, Washington, D.C., January, 1977.

Table V. Interstate shipments of natural gas in West Virginia in 1975

	Amount (ft ³ × 10 ⁹)
Marked production	154.4
Receipts	962.1
80.1% from Kentucky	
19.9% from Ohio	
Shipments	915.9
73.4% to Pennsylvania	
25.8% to Virginia	
0.8% to Maryland	
Retained for consumption	200.9
Consumption	167.7
Δ Underground storage	+34.7

Table VI indicates the interstate shipment of crude oil in the state in 1975. West Virginia is a net importer of crude oil, all of which comes from Kentucky (43% by pipeline, 35% by barge, and 22% by truck). Approximately 97% of all intrastate shipments of crude oil are by pipeline. There are no foreign shipments. There are 2939 miles of pipeline in the state, 91% of which are crude gathering lines.

Table VI. Interstate shipments of crude oil in West Virginia in 1975

	Amount (bbl × 10 ³)
Production	2479
Receipts	3359
100.0% from Kentucky	
Shipments	123
100.0% to Pennsylvania	
Retained for consumption	5715
Refinery gain	5
Crude runs to stills	5720

Coal. Coal is the economic lifeblood of the state employing 10% of the work force. There are 891 active coal mines located in 33 of the 55 counties in the state. Average weekly earnings in 1975 amounted to \$277.45, an 87% increase over the past ten years. The average weekly

Fig. 2. West Virginia oil production.

earnings in manufacturing were \$190.12. The average price of coal in West Virginia was \$25.00 versus a national average price of \$18.75. The overall unemployment rate in the state in 1975 was slightly below the U.S. average (8.2% versus 8.5%).

Investigations have been initiated on academic and state levels attempting to assess the possible methods of coal utilization. The state is now involved with two important coal technology demonstration plants: (1) a 2-3 megawatt fluidized bed combustion unit in Rivesville and (2) a coal liquefaction plant in Cresaps. West Virginia University has undertaken a study to determine the feasibility of setting up coal complexes throughout the state that produce natural gas, petroleum liquids, and electric power.

The winter seasons have resulted in substantial losses in coal production due to weather effects at mine sites and on transportation systems. Coal car shortages occurred because of difficulties unloading frozen coal at delivery points. Barge traffic was slowed because of ice on the Ohio, Kanawha, and Monongahela Rivers. The gas shortages have affected coal car thawing systems at delivery points, thus slowing hopper-car unloading operations.

Coal producers pay a business and occupation tax to the state (3.85%). The state distributes 10% of this tax revenue to the counties, 7.5% to the producing counties and 2.5% to the non-producing counties. Producers also pay a corporate income tax of 6% of net income. No sales or severance taxes are imposed.

The state is a net exporter of coal, the bulk being shipped to Ohio, Michigan, and Pennsylvania. Table VII indicates the shipments of bituminous coal in 1975. Coal is the most important mineral product of the state in terms of value.

THE SUPPLY OF ENERGY: Energy Outputs

Petroleum Products. There are 3 refineries in the state: Pennzoil in Falling Rock, Quaker State in Newell, and Quaker State in St. Marys. They have a combined capacity of 20.2 thousand barrels of oil per stream day. There is no asphalt capacity, but all three refineries employ catalytic reforming and catalytic hydro treating to enhance the production of lighter distillates and gasoline. Though West Virginia is the smallest per capita consumer of gasoline in the region, the state is a net importer of petroleum products.

There are 4 natural gas processing plants in the state with a capacity of 368.5 million cubic feet of gas per day. Columbia Gas Transmission Corporation has the Cobb plant in Kanawha county and the Kenova plant in Wetzel county, and Pennzoil has 13 very small plants. In 1975 these plants produced 11.6 billion barrels of raw NGL, ethane, propane, and etc.

Table VII. Shipments of bituminous coal in West Virginia in 1975
(tons $\times 10^6$)

Total production	109,283
Shipments	103,183
Rail, 81.5%	
Truck, 5.1%	
Water, 13.4%	
Nonmarketed production	6,100
Mine-mouth facilities, 97.0%	
Other, 3.0%	
Receipts	34,360
Electric utilities, 76.6%	
Coke and gas plants, 13.0%	
Retail dealers, 0.5%	
Other, 9.9%	

Electricity. There are 8 hydro plants and 13 fossil fuel plants in the state, most of the latter being coal-fired. All of the generating capacity is investor-owned. At least 99% of the generation is from conventional steam plants and only 1% from hydro generation. There is no use of internal combustion. Per capita generation of electricity is 3.8 times more than the national average.

THE DEMAND FOR ENERGY

The fuel mix of each sector is shown in Table VIII. The largest energy user is the electric utilities, followed by the industrial sector. The residential-commercial sector consumes only 8% of the total energy. Natural gas supplies 17% of the energy needs of the state, as do petroleum products. The transportation sector uses more natural gas for pipeline transport than is typical.

Residential. West Virginia has 48% more mobile homes and 20% more single-family housing units than is typical. Natural gas is the pre-dominant fuel used for space and water heating, as well as for cooking. There are roughly half as many dishwashers and airconditioners per household as is generally the case.

Table IX indicates the fuel usage per capita of the residential sector relative to the region and the nation in 1975. It also presents the equivalent Btu fuel prices paid and how they relate to prices prevailing nationally. Natural gas usage is 23% higher than the national average, with distillate and kerosene oil usage below normal. Natural gas prices are 15% lower in West Virginia than other states, with electricity and fuel oil prices approximately the same.

Table VIII. Fuel mix by sector in West Virginia in 1974
(Btu $\times 10^{12}$)

Sector	Percentage					Total (Btu)
	Coal	Oil	Gas	Hydropower	Nuclear	
Residential-commercial	8.6	13.4	78.0			102.5
Industrial	57.5	16.9	25.6			439.5
Electric utilities	97.8	1.4	0.0	0.8	0.0	564.6
Transportation		88.3	11.7			136.7
Total	65.4	17.4	16.8	0.4	0.0	1245.2

Table IX. Fuel use by the residential sector in West Virginia in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Petroleum	11.9	0.42	2.76	1.07	5.4	0.41
Natural gas	64.4	1.26	1.42	0.85	29.1	1.23
Electricity	20.2	1.00	9.58	1.02	9.2	0.98
Coal	3.5	4.38			1.6	4.22

Commercial. Approximately 55% of the employees of the state are engaged in commercial activity (13% less than the national average). The state has a low mix of employees engaged in finance, insurance, and real estate activities. Table X indicates the fuel mix, equivalent Btu fuel prices paid, and fuel usage per commercial employee in the state in 1975. The sector is most reliant upon natural gas, 52% more so than is typical. Note, however, that it is coal usage which is extremely high relative to national norms. Natural gas prices are 10% less and electricity prices approximately the same. On a per employee basis, coal usage is 5.4 times greater than average, and gas consumption 57% greater. Fuel oil is relatively underutilized, and electricity usage approximately the same.

Manufacturing. About 38% of the employees in the state are in the industrial sector, and 61% of these employees are engaged in manufacturing activities. Table XI presents energy-intensiveness indices for each two-digit SIC in the state in 1974. Oil usage per worker is 29% higher in West Virginia, coal usage 12.4 times as great, natural gas usage 91% higher, and electricity usage 2.7 times as great as the national average. Overall, the manufacturing sector uses about 3 times as much energy per workers as do manufacturing sectors in other states. Oil usage per

Table X. Fuel use by the commercial sector in West Virginia in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Petroleum	10.2	0.31	2.76	1.07	13.3	0.32
Natural gas	61.9%	1.52	1.19	0.90	80.3	1.57
Electricity	24.2	0.94	9.25	1.00	31.8	0.96
Coal	3.7	5.29			4.8	5.44

Table XI. Energy intensiveness indices of manufacturing in West Virginia in 1974

SIC	Oil	Coal	Gas	Electricity	Total energy
20	0.37	0.45	0.20	0.29	0.22
24	0.77	6.36	0.91	0.51	0.40
26	0.00	0.00	0.09	0.21	0.57
27	1.53	0.00	2.59	1.44	0.94
28	0.51	8.37	0.84	1.53	1.91
29	5.95	0.10	0.36	0.74	0.83
30	0.27	0.00	1.71	0.53	0.38
31	0.00	0.00	0.00	1.23	8.75
32	0.16	0.00	1.06	0.70	0.84
33	1.19	11.95	0.93	1.61	1.61
34	0.34	0.56	1.38	1.56	1.23
35	1.47	0.00	3.46	0.80	1.08
36	7.00	14.60	6.41	6.66	4.92
38	0.00	0.00	13.89	1.19	2.51
Average	1.29	12.44	1.91	2.72	2.94

worker is exceptionally high in petroleum refining and coal and in the manufacture of electrical equipment. Coal usage is notably high in the lumber industry, chemicals, primary metals, and manufacture of electrical equipment. Natural gas usage is especially high in electrical equipment. The largest per employee energy user in the state is the leather industry and electrical equipment industry. The smallest energy users are food, lumber, and rubber and plastics.

Table XII indicates the fuel mix of this sector, equivalent Btu fuel prices paid, and fuel usage per manufacturing employee. The sector is most reliant upon coal, 4.2 times as much so as is normal. Electricity prices are 10% less than the national average, coal prices 7% less, and natural gas prices 12% higher. Overall, the cost of the fuel to the sector is 29% above the national average.

Table XII. Fuel use by the manufacturing sector
in West Virginia in 1974

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	39.6	4.24	0.81	0.93	213.3	11.63
Oil	5.7	0.44	2.08	1.09	30.6	1.21
Gas	31.9	0.65	0.75	1.12	171.8	1.79
Electricity	14.5	0.92	3.66	0.90	78.1	2.54
Coke	0.2	0.09	1.99	1.30	1.3	0.00
Total	91.9		1.29	0.89	538.2	2.74

Electric Utilities. Table XIII indicates the fuel mix, equivalent Btu fuel prices, and fuel usage per capita of the electric utility sector. Coal is the predominant fuel utilized, 2.2 times more so than is typical. Coal prices, however, are 10% higher. The average cost of generating a kilowatt hour of electricity, however, is 12% less than the national average. Per capita coal usage is 8.4 times higher than the average, with per capital electrical generation 3.8 times as great.

Table XIII. Fuel use by the electric utility sector in
West Virginia in 1975

Fuel	Mix (%)	Ratio	Price (\$/10 ⁶ Btu)	Ratio	Share	Ratio
Coal	98.5	2.21	0.95	1.10	33,562	8.39
Oil	0.7	0.04	2.10	1.05	223	0.16
Hydropower	0.8	0.05			259	0.18
Gas	0.0	0.00			16	0.01
Total	100.0		0.95	0.88	34,060	3.79

ENVIRONMENTAL ISSUES

Air quality in West Virginia is mixed. Particulate standards are not being met in the Weirton-Wheeling, Kanawha Valley, Central, and North Central portions of the state. Oxidant standards are not met anywhere in the state. Sulfur-dioxide standards are not met in Weirton-Wheeling.

Water quality is poor in several areas, but has improved over time. Pollution from coal mining or industrial discharges is found in major stretches of the Ohio, Monongahela, Kanawha, and Little Kanawha Rivers.

Coal is at the root of most environmental-energy issues in the state. West Virginia had strict regulations on the sulfur content of coal burned in power plants. The governor ordered the state not to enforce SO₂ regulations since miners were out of work. He argued the unfairness of West Virginia's relatively stringent standards, particularly as they compared to those of Ohio. The state Air Pollution Control Commission, following his executive order, took the necessary action to relax sulfur-dioxide standards, such that state standards are no more stringent than federal standards. Principal beneficiaries included producers of high-sulfur coal in the northern counties of the state. The new standards place electric power plant emission regulations on a par with those at power plants across the Ohio River where current regulations allow burning of high-sulfur coal.

EPA has proposed that present acide mine drainage control regulations be replaced by a barring of such discharges following abandonment. Gravity discharge from the mine portal would no longer be permitted, and larger coal barriers would be required on the down-dip side of such mines. Essentially watertight seals would be required when mining is completed. Industry is, not surprisingly, concerned as to the adverse effects of such standards.

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- TABLE II. Population is from "Current Population Reports," Series P-25, U.S. Department of Commerce, Bureau of Census (Washington, D.C.: U.S. Government Printing Office, 1976). Energy consumption data is from L. H. Crump, Fuel and Energy Data: U.S. by States and Census Regions, 1974, Information Circular 8739 (Washington, D.C.: U.S. Government Printing Office, 1977).
- FIGURE 1. DeGolyer and MacNaughton, Twentieth Century Petroleum Statistics, 1977 (Dallas: DeGolyer and MacNaughton, October 1977), pp. 82-86.
- FIGURE 2. Federal Power Commission, map entitled "Major Natural Gas Pipelines," December 31, 1974.
- TABLE III. "Natural Gas Production and Consumption: 1975," op. cit.
- TABLE IV. Federal Energy Administration, 1976 National Energy Outlook, FEA-N-75/713 (Washington, D.C.: U.S. Government Printing Office, 1976), p. 125.
FEA/FPC Distributor Survey, December 1975.
- FIGURE 3. DeGolyer and MacNaughton, op. cit., pp. 29-33.
- TABLE V. "Crude Oil, Petroleum Products, and Natural Gas Liquids: 1975," op. cit.
- TABLE VI. Ibid.
- TABLE VII. "Coal--Bituminous and Lignite in 1975," op. cit.
- FIGURE 4 Prepared by Dr. Robert Honea of the Regional and Urban
FIGURE 5 Studies Section of the Energy Division of ORNL from
FIGURE 6 information provided by the Federal Power Commission.
FIGURE 7
- TABLE VIII. Federal Power Commission, "FPC Releases Preliminary 1975 Power Production, Capacity, Fuel Consumption Data," No. 22686 (Washington, D.C.: FPC, October 1976).
- TABLE IX. Fuel and Energy Data: U.S. by States and Census Regions, 1974, op. cit.
- TABLE X. Ibid.
- TABLE XI. Ibid.
- TABLE XII. Mary Zitomer, "Sales of Fuel Oil and Kerosine in 1975," Mineral Industry Surveys, U.S. Department of the Interior,

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TABLE XVI. County Business Patterns: 1974, U.S. Department of
TABLE XVII. Commerce (Washington, D.C.: U.S. Government Printing
TABLE XVIII. Office, July 1975).

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- APPENDIX E. "Coal--Bituminous and Lignite in 1975," op. cit.
- APPENDIX F. Federal Power Commission, computer tape.
- APPENDIX G. The flow data was obtained from Form 412 reports filed with the Federal Power Commission annually by all power companies. For each transmission line crossing state boundaries, the kilowatt hour flow was noted. The numbers are based upon estimations reported in National Energy Transportation, Volume I, Committee on Energy and Natural Resources, 95th Congress, 1st Session, U. S. Senate, Publication No. 95-15, May 1977. (It was assumed that the states exported the same percentage of generated electricity in 1975 as they had in 1974.)
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IV. CONVERSION FACTORS

Crude Oil	5,800,000 BTU per barrel
Natural Gas Liquids	4,032,629 BTU per barrel
Gasoline	5,248,000 BTU per barrel
Distillate Oil	5,825,000 BTU per barrel
Residual Oil	6,287,000 BTU per barrel
Kerosene and Jet Fuel	5,670,000 BTU per barrel
Liquid Petroleum Gas	4,011,000 BTU per barrel
Natural Gas (production)	1,093,000 BTU per mcf
Natural Gas (consumption)	1,021,000 BTU per mcf
Coal (production)	
Alabama	25,740,000 BTU per short ton
Arkansas	28,760,000 BTU per short ton
Florida & Georgia	25,460,000 BTU per short ton
Kentucky	24,812,000 BTU per short ton
Mississippi	25,740,000 BTU per short ton
North Carolina	24,340,000 BTU per short ton
Oklahoma	25,240,000 BTU per short ton
South Carolina	25,460,000 BTU per short ton
Tennessee	26,200,000 BTU per short ton
Texas	13,200,000 BTU per short ton
Virginia	26,360,000 BTU per short ton
West Virginia	26,800,000 BTU per short ton
U. S.	26,200,000 BTU per short ton
Hydro (generation)	3,412,000 BTU per mkwh
Nuclear (generation)	
Alabama	10,654,000 BTU per mkwh
Arkansas	10,526,000 BTU per mkwh
Florida	10,664,000 BTU per mkwh
Georgia	11,364,000 BTU per mkwh
South Carolina	10,663,000 BTU per mkwh
Virginia	10,667,000 BTU per mkwh
U. S.	10,662,000 BTU per mkwh
Electricity (consumption)	3,412,000 BTU per mkwh

^aOne joule = 1054.8 BTU

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