N O T I C E

THIS DOCUMENT HAS BEEN REPRODUCED FROM MICROFICHE. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE

TDC-80-005

TECHNOLOGY
DEVELOPMENT
CORPORATION

COAL CONVERSION PRODUCTS INDUSTRIAL APPLICATIONS

28 FEBRUARY 1980

MR. JOSEPH H. DUNKIN
MR. DENNIS WARREN

NASA CONTRACT NAS8-33759
COR: MR. RODNEY BRADFORD

(NASA-CR-161469) COAL CONVERSION PRODUCTS INDUSTRIAL APPLICATIONS (Technology Development Corp.) 213 p HC A10/MF A01 CSCL 21D
N80-24465
Unclas
G3/28 22336

SECTION 1. REPORT SECTIONS

REPORT SECTIONS

This report summarizes Technology Development Corporation's (TDC) three-month study contract (NAS8-33759) for NASA/MSFC entitled "Coal Conversion Products Industrial Applications". The report is documented in a briefing format; each viewgraph prepared in the study has a brief explanation on the facing page. The sections in the report are divided into the major study tasks, conclusions, and recommendations and methodologies.

Additional reports and data were prepared by TDC during this three-month period and were delivered to NASA. Copies of these reports are available upon request. Data and reports prepared are the following:

1. Medium-BTU Gas Toxicity
2. Indirect Liquefaction of Coal to Produce Gasoline
3. Synfuels Facility Products and Revenues
4. Synfuel Congressional Legislation
5. Gas Pipeline Regulations
6. Natural Gas and Fuel Oil Demand in Northern Alabama and South Central Tennessee.

REPORT SECTIONS

1. Study Objectives and Summary
2. Summary of Existing Industries
3. Projected Industrial Growth
4. Current and Projected Synthetic Fuels Applications
5. Characterization of Industries Surrounding Candidate Areas
6. Conclusions
7. Recommendations and Methodologies

STUDY OBJECTIVES

Coal-based synthetic fuels complexes are under development consideration by NASA/MSFC. These complexes will initially produce large quantities of synthetic fuels, primarily medium-BTU gas (MBG). The synthetic fuels could be sold commercially to industries possibly located in South Central Tennessee and Northern Alabama. The synthetic fuels complexes would be modular in construction with the first module producing MBG in the 1980's. Subsequent modules may produce liquid fuels or fuels for electrical power production.

The purpose of this study is to identify current and projected new industries in Tennessee and Northern Alabama which will have a propensity to utilize synthetic coal fuels. A data base of TVA region industries has been compiled, analyzed, and provided to NASA/MSFC to support coal gasification facility conceptual definitions.

COAL CONVERSION PRODUCTS
INDUSTRIAL APPLICATIONS
STUDY OBJECTIVES

- ESTABLISH INDUSTRIAL APPLICATIONS DATA BASE FOR SYNTHETIC FUELS AT NASA/MSFC
- CANDIDATE AREAS TO BE STUDIED ARE NORTHERN ALABAMA AND TENNESSEE
- DETERMINE CURRENT AND PROJECTED INDUSTRY FEEDSTOCK AND ENERGY REQUIREMENTS
- CATEGORIZE INDUSTRIES BY ENERGY USEAGE AND GEOGRAPHIC LOCATION RELATIVE TO FUEL DISTRIBUTION
- DETERMINE SYNTHETIC FUEL UTILIZATION BY CURRENT AND PROJECTED INDUSTRIES

STUDY SCHEDULE

The study was conducted over a three-month period from November 14, 1979, through February 15, 1980. A total of 765 manhours were expended on the study.

STUDY SCHEDULE

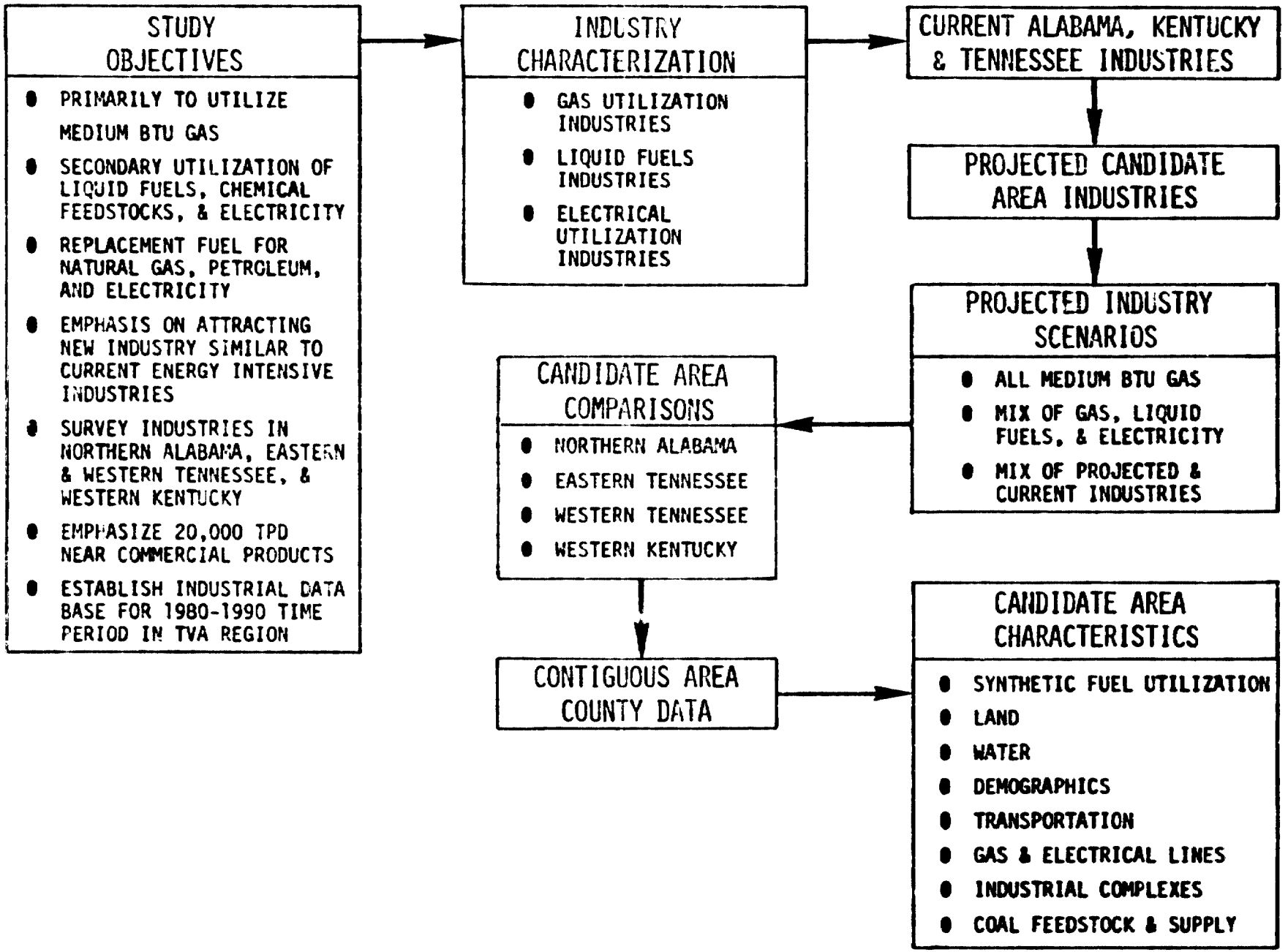
ITEM	WEEKS AFTER CONTRACT AWARD														CONTRACT MAN HOURS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1. INITIAL CO-ORDINATION MEETING WITH COR	▲														
2. SUMMARY OF EXISTING INDUSTRIES	▬	▬	▬	▬											160
3. PROJECTED INDUSTRIAL GROWTH		▬	▬	▬	▬	▬	▬	▬	▬						185
4. CURRENT & PROJECTED SYNTHETIC FUELS APPLICATIONS		▬	▬	▬	▬	▬	▬	▬	▬						280
5. CHARACTERIZATION OF INDUSTRIES SURROUNDING CANDIDATE AREAS					▬	▬	▬	▬	▬	▬					140
6. FINAL BRIEFING AT NASA/MSFC												▲			
7. FINAL REPORT DELIVERY														▲	
8. PROGRESS REPORTS				▲				▲				▲			
													TOTAL:		765

ORIGINAL PAGE IS
OF POOR QUALITY

TECHNICAL APPROACH

An overview of the study technical approach is shown. The study plan was finalized after meeting with the COR at MSFC one week after contract award. Initial study efforts were concentrated on national, state, regional, county, and industrial energy, land, and demographic data collection. Current and projected TVA region industry utilization of energy, including its form, was analyzed and determined. Synthetic fuels complex candidate areas in Northern Alabama were identified and agreed upon with the COR. From specific candidate areas, potential industrial utilization of synthetic fuels was determined for approximate medium-BTU gas pipeline configurations. Industrial characteristics were summarized for each candidate area, such as synthetic fuel utilization, resource requirements and availability, transportation and utility requirements and availability, and coal feedstock supply and demand.

TECHNICAL APPROACH



KEY DATA SOURCES

TDC collected data from local, state, regional, and federal agencies and libraries. Professional societies and industrial research organizations also provided relevant information. TDC also conducted industrial surveys for actual consumption of natural gas, fuel oil, and electricity.

THE TECHNOLOGY DEVELOPMENT CORPORATION
COAL CONVERSION DATA BASE
— KEY DATA SOURCES —

PUBLIC AGENCIES

- FEDERAL AGENCIES
  - DOE
  - CENSUS BUREAU
  - TVA
  - LIBRARY OF CONGRESS
- STATE AGENCIES
  - ALABAMA DEVELOPMENT OFFICE
  - TENNESSEE DEPARTMENT OF ECONOMIC AND COMMUNITY DEVELOPMENT
  - KENTUCKY CHAMBER OF COMMERCE
  - ALABAMA ENERGY MANAGEMENT BOARD
  - WATER RESOURCE AGENCY
  - SOIL CONSERVATION SERVICE
  - GEOLOGY DEPARTMENT
- LOCAL AGENCIES
  - REGIONAL COUNCIL OF GOVERNMENTS (TARCOG)
  - HUNTSVILLE CHAMBER OF COMMERCE
  - HUNTSVILLE UTILITIES
  - RSIC
  - UAH LIBRARY

PUBLISHED LITERATURE

- FORMAL REPORTS (120)
- FORMAL TEXTBOOKS (15)
  - CHEMICAL ENGINEERING
  - CHEMISTRY
  - COST ANALYSIS
- PERIODICALS
  - CHEMICAL AND ENGINEERING NEWS
  - CHEMICAL ENGINEER
- GENERAL MEDIA
  - BUSINESS WEEK
  - HUNTSVILLE TIMES

PROFESSIONAL SOCIETIES

- AMERICAN CHEMICAL SOCIETY
- AMERICAN INSTITUTE OF CHEMICAL ENGINEERS
- AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

INDUSTRIAL RESEARCH ORGANIZATIONS

- AMERICAN GAS ASSOCIATION
- GAS RESEARCH INSTITUTE
- ELECTRIC POWER RESEARCH INSTITUTE

INDIVIDUAL CORPORATIONS

- 30 HUNTSVILLE COMPANIES

COMPARISON OF MARKET ESTIMATES

TDC analyzed over 1,200 companies in eight load centers for the Northern Alabama and South Central Tennessee region. The summarized results of the analysis indicate a high of 169 trillion BTU/YR potential for medium-BTU gas (MBG) and a low of 72 trillion (BTU/YR (TBTU/YR). Two MBG replacement of industrial natural gas and fuel oil estimating techniques were developed by TDC; an expected value and a high-low technique. The expected value for MBG potential is 110 TBTU/YR and the high-low technique estimates 72 TBTU/YR of current industrial consumption. The Census Bureau data in 1976 shows 169 TBTU/YR of industrial natural gas and fuel oil useage. TVA provided data to NASA for pipeline studies indicating 157 TBTU/YR were currently being used by industries. As a comparison, the coal gasification facility is estimated to produce 75-100 TBTU/YR of medium-BTU gas. Therefore, for the facility to be feasible, most industries would have to replace natural gas and fuel consumption with medium-BTU gas, or the region under consideration will have to attract new industries for utilization of MBG. This also implies an extensive MBG pipeline.

An alternative to MBG production would be the other synthetic fuels such as gasoline, fuel cells generating electricity, or synthetic natural gas.

COMPARISON OF MARKET ESTIMATES*

LOAD CENTER	EXPECTED VALUE TECHNIQUE	HIGH-LOW TECHNIQUE	CENSUS BUREAU	NASA PIPELINE DATA
• CHATTANOOGA	17.0	12.0	24.0	25.0
• CENTRAL TENNESSEE	6.0	0.2	--	--
• NORTHEAST ALABAMA	15.0	4.0	11.0	4.0
• NORTHWEST ALABAMA	25.0	22.0	33.0	30.0
• HUNTSVILLE	1.0	0.5	3.0	2.0
• MEMPHIS	8.0	0.0	33.0	34.0
• NASHVILLE	6.0	3.0	16.0	16.0
• BIRMINGHAM	32.0	30.0	49.0	46.0
	110.0	72.0	169.0	157.0

*ALL NUMBERS ARE IN TRILLION BTU'S PER YEAR.

MARY OF FINDINGS

TDC concluded only major industries consuming at least one trillion BTU's per year (TBTU/YR) should be considered for medium-BTU gas consumption, since pipeline expense (~$1 Million/Mile) and plant retrofit costs are expected to be high. No major energy consumers were found in the surveys of Madison County. It is expected the 75-100 TBTU/YR facility will saturate the market for industrial gas consumption. Projected energy growth due to new industries or expansion of current industries will be necessary for facility justification.

SUMMARY OF FINDINGS

- MADISON COUNTY SURVEY REVEALED NO INDUSTRIAL ENERGY CONSUMERS WHO CONSUMED ONE TRILLION BTUs PER YEAR OR MORE
- REGIONAL CENSUS BUREAU ENERGY CONSUMPTION DATA INDICATED A POTENTIALLY LARGE MBG MARKET UP TO 169 TRILLION BTUs PER YEAR
- TDC DETAILED ANALYSIS OF 180 SPECIFIC PLANTS, SELECTED FROM 1200 COMPANIES, INDICATED A REGION-WIDE MARKET FOR MEDIUM BTU GAS UP TO 110 TRILLION BTUs PER YEAR
- TOTAL PROJECTED OUTPUT, IN BTUs, FROM THE GASIFICATION FACILITY IS A VERY HIGH PERCENTAGE (APPROX. 71%) OF THE HISTORICAL NATURAL GAS AND FUEL OIL MARKET IN THIS REGION

CONCLUSIONS

For the Northern Alabama and South Central region, three industries stood out as primary potential consumers of MBG; that is, basic metals, chemicals and rubber industries. Four plants are currently consuming almost half of the industrial energy in this area: U.S. Steel, Reynolds, Amoco, and C. F. Industries.

If an MBG pipeline were only constructed across Northern Alabama, current industries could only absorb one-fourth or one module of the facility. Compounded industrial energy growth of four percent could consume two modules' output, six percent growth could consume three modules' output. Therefore, alternate synfuels products should be considered if the pipeline is only constructed across Northern Alabama.

CONCLUSIONS

- IN THIS REGION, THE PRINCIPAL MBG USERS WOULD BE THE BASIC METALS, CHEMICAL, AND RUBBER INDUSTRIES
- FOUR COMPANIES HAVE A CRITICAL IMPACT ON THE POTENTIAL SIZE OF THE REGIONAL MBG MARKET (50% OF MARKET)
  - U.S. STEEL, BIRMINGHAM
  - REYNOLDS METALS, SHEFFIELD
  - AMOCO CHEMICAL, DECATUR
  - C.F. INDUSTRIES, CHATTANOOGA
- CURRENT NORTH ALABAMA MARKET CAN ABSORB MBG PRODUCTION FROM ONE MODULE
- PROJECTED NORTH ALABAMA MARKET CAN ABSORB MBG PRODUCTION FROM THREE MODULES
- NEW INDUSTRIES COULD ABSORB MBG PRODUCTION FROM FOURTH MODULE
- ALTERNATIVELY, FOURTH MODULE COULD PRODUCE SYNFUELS OTHER THAN MBG

TDC QUICK-RESPONSE STUDIES

TDC provided to NASA data and reports in order to provide quick-response analysis of synthetic fuels. Copies of these reports and data are available upon request.

TDC QUICK-RESPONSE STUDIES

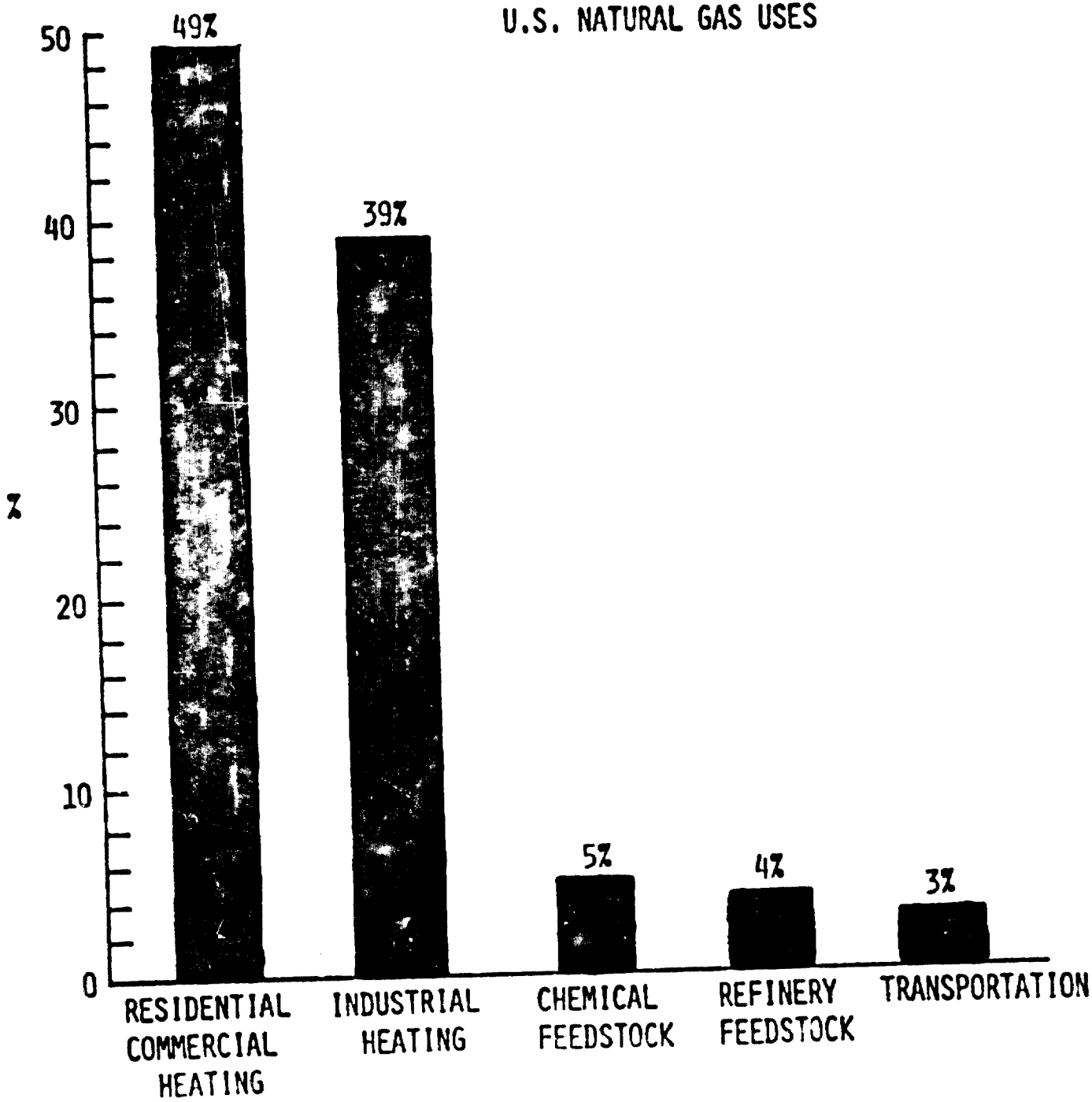
- The Toxicity of Medium-BTU Gas
- Energy and Revenue Produced by Synthetic Fuel Complexes
- Liquefaction of Coal to Produce Gasoline
- Pipeline Regulations
- Synfuel Bills before Congress
- Natural Gas and Fuel Oil Demand in Northern Alabama and Central Tennessee

SECTION 2. SUMMARY OF EXISTING INDUSTRIES

U.S. NATURAL GAS USES

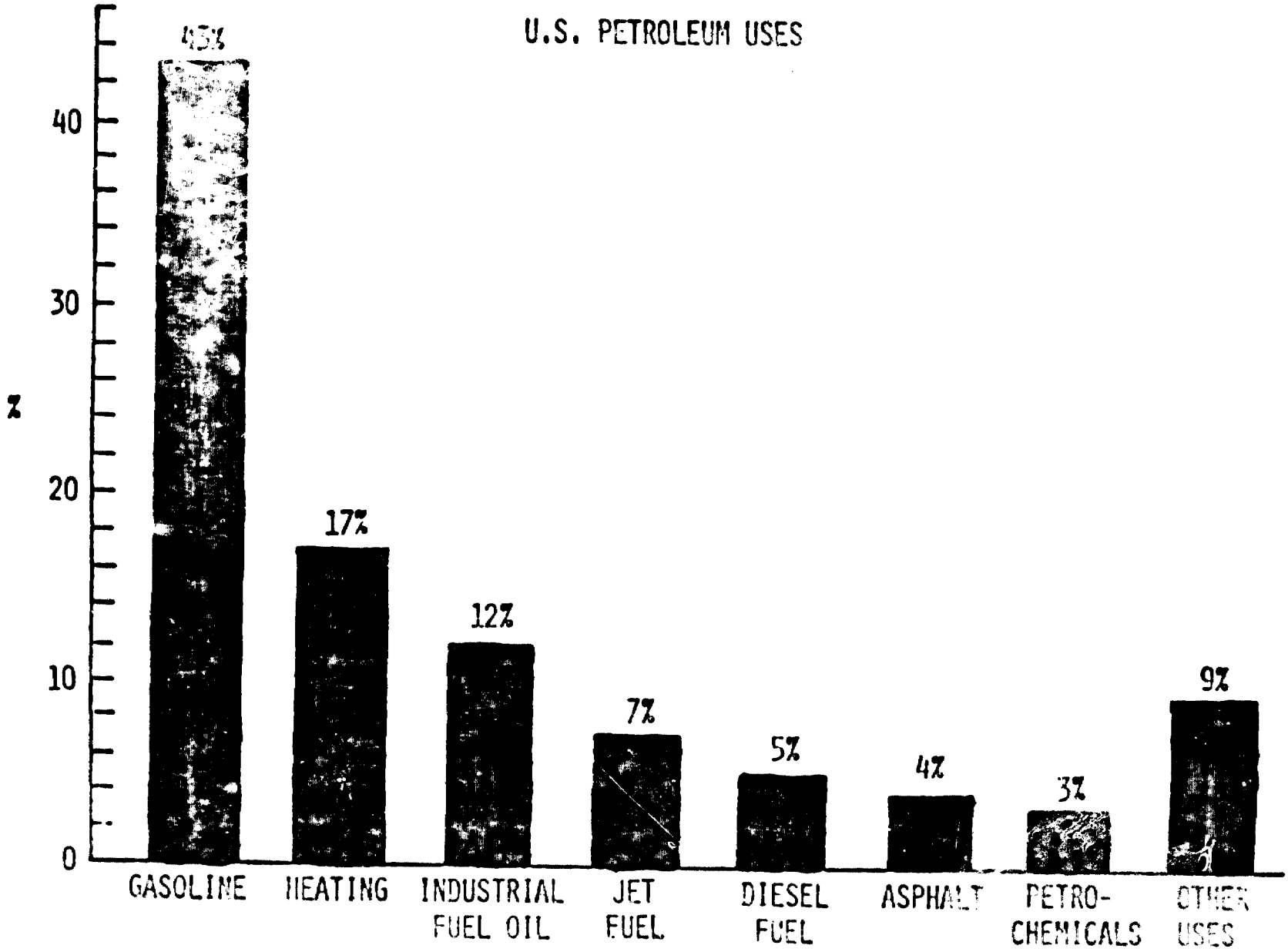
The primary objective of development of the Coal Gasification Facility is to replace industrial uses of natural gas with medium-BTU gas (MBG), and to reduce the useage of imported oil. If industries are curtailed from natural gas, imported oil is substituted. Also, electricity is a replacement for natural gas, and utilities use large amounts of oil to generate electricity. Therefore, emphasis on replacement, or supplementation of natural gas with MBG, reduces imported oil useage. Currently in the U.S., 88% of natural gas is used for heating; industrial heating consumes 39%. Therefore, emphasis should be on replacing industrial heating with MBG, with a secondary consideration for chemical feedstock.

ORIGINAL PAGE IS
OF POOR QUALITY



U.S. PETROLEUM USES

The majority of petroleum is converted to gasoline. Heating and industrial fuel oil also use significant amounts of petroleum. Therefore, if the primary objective of the coal gasification is to reduce imported oil, liquefaction of coal for production of gasoline may be attractive. TDC prepared a separate report entitled "Indirect Liquefaction of Coal to Produce Gasoline", which addressed the feasibility of the coal→methanol→gasoline process and economics.


U.S. PETROLEUM USES
%
0
10
20
30
40
43%
17%
12%
7%
5%
4%
3%
9%
GASOLINE
HEATING
INDUSTRIAL FUEL OIL
JET FUEL
DIESEL FUEL
ASPHALT
PETRO-CHEMICALS
OTHER USES

NATIONAL MBG POTENTIAL BY MAJOR SIC CODE

Nationwide a large potential for MBG exists if natural gas and fuel oil are replaced. Again, a large percentage of energy is used by industries for heating and process steam. Chemicals, primary metals, petroleum refining, and paper industries are major consumers of energy and use most of the energy for heating. The average energy consumption by industry type is largest for petroleum refining, chemicals, and primary metals.

NATIONAL MBG POTENTIAL BY MAJOR SIC CODE (1975)

SIC	Description	MBG Potential* (10^{12} BTU/yr)	% of Industrial Energy Consumption For Direct Heat & Process Steam	Average Energy Consumption Per Industrial Establishment (10^9 BTU)
28	Chemicals	1,818	69	[illegible]
33	Primary Metals	1,396	79	299
29	Petroleum Refining	1,124	89	750
26	Paper	672	63	198
32	Stone, Clay, & Glass	248	23	76
20	Food	120	15	32
10	Metal Mining	53	40	131

*DOES NOT INCLUDE GAS FEEDSTOCK APPLICATION

TOTAL ENERGY CONSUMPTION

Total energy consumption in Alabama and Tennessee is about 1 quad (~1,000 trillion BTU/YR). Gasoline, natural gas, and fuel oil constitute around three-fourths of the total energy consumption. In Tennessee, energy growth is projected to be an average of 1% per year. Energy growth, particularly industrial, has been declining during the 1970's due to conservation.

ORIGINAL PAGE IS OF POOR QUALITY

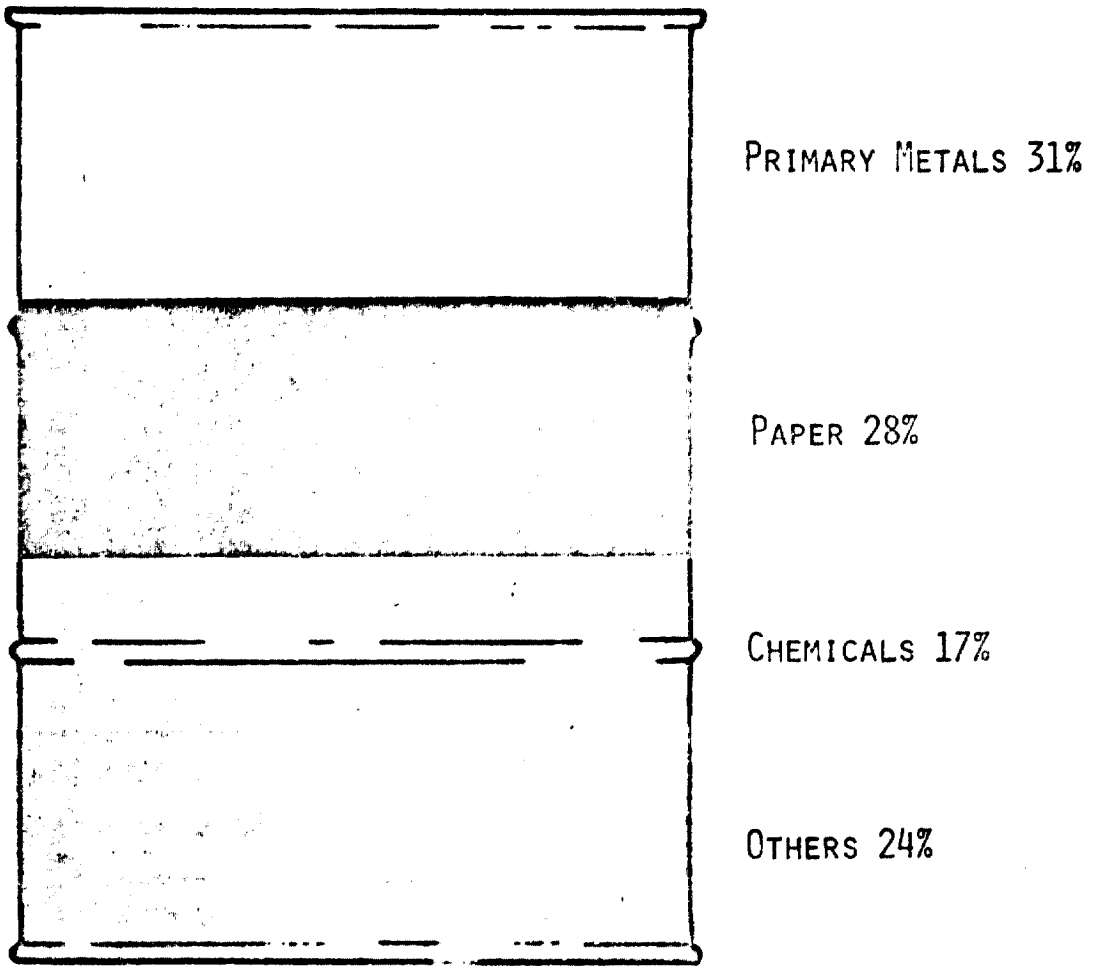
TOTAL ENERGY CONSUMPTION
(INDUSTRIAL, COMMERCIAL, RESIDENTIAL)
(TRILLIONS BTU/YR)

	ALABAMA	TENNESSEE	
	1976	1977	1986
ELECTRICITY CONSUMPTION	156.2	171.0	203.9
NATURAL GAS CONSUMPTION	227.1	185.8	179.5
COAL CONSUMPTION	182.8	186.9	222.0
RETAIL GASOLINE CONSUMPTION	277.9	337.1	392.3
FUEL OIL CONSUMPTION	251.2	145.1	171.7
NET ENERGY CONSUMPTION	1,095.2	1,025.9	1,169.4

ALABAMA INDUSTRIAL ENERGY CONSUMPTION

In Alabama, as nationwide, primary metals, paper, and chemicals consume most of the industrial energy. As was shown before, most of the energy goes for heating.

1975 ENERGY CONSUMPTION OF ALABAMA INDUSTRIES



ENERGY SURVEY

TDC conducted an energy survey of major Madison County firms in order to ascertain natural gas, fuel oil, and electrical useage. About half of the firms responded to the survey, which provided useful information on curtailments, amounts of energy used, types, and average monthly demand. The information obtained from the industries is treated as proprietary.

ENERGY SURVEY

MADISON COUNTY

1. DUNLOP TIRE & RUBBER
2. PPG INDUSTRIES
3. MALLORY CAPACITOR
4. ENGELHARD MINERALS
5. TELEDYNE WAH CHANG
6. AUTOMATIC ELECTRIC
7. CHRYSLER CORPORATION
8. HUNTSVILLE MANUFACTURING
9. BARBER COLMAN
10. JOHN BLUE COMPANY
11. UNION CARBIDE
12. MARTIN INDUSTRIES
13. OWENS-CORNING
14. THIOKOL
15. GENERAL SHALE
16. SCI SYSTEMS
17. MEADOW GOLD DAIRIES
18. CHEESEBROUGH-POND'S
19. AMERICAN BREAD
20. LUCKY MANUFACTURING
21. COYNE CYLINDER
22. COLONIAL BAKING
23. AMERICAN DATA
24. AC ELECTRONICS
25. NORTON COMPANY
26. ASTRO SPACE
27. BEOWULF
28. HALL CHEMICAL
29. H.D. LEE
30. SCHAEFER

LARGE NORTHERN ALABAMA INDUSTRIES

TDC obtained industrial energy useage data from surveys, published reports, and from TVA. Major energy consuming industries are plants that employ greater than one hundred employees or consume greater than 500 billion BTU/YR in natural gas and fuel oil. Over 1,200 companies in Northern Alabama and South Central Tennessee were analyzed. The data was compiled by Standard Industrial Code (SIC) to avoid disclosing sensitive information.

LARGE NORTH ALABAMA INDUSTRIES

COMPANY NAME	LOCATION	NUMBER OF EMPLOYEES
1. GENERAL MOTORS SAGINAW STEERING GEAR DIVISION	ATHENS, LIMESTONE COUNTY	2,000
2. CHAMPION INTERNATIONAL	COURTLAND, LAWRENCE COUNTY	1,000
3. NICHOLSON FILE CO.	CULLMAN, CULLMAN COUNTY	1,000
4. MONSANTO CO.	DECATUR, MORGAN COUNTY	2,500
5. PRESOLITE, INC.	DECATUR, MORGAN COUNTY	1,000
6. THREE M CO., INC.	DECATUR, MORGAN COUNTY	1,500
7. UNIVERSAL OIL PRODUCTS, INC.	DECATUR, MORGAN COUNTY	1,000
8. GOOD YEAR TIRE AND RUBBER CO., INC.	GADSDEN, ETOWAH COUNTY	4,000
9. HEALTH-TEC, INC.	GADSDEN, ETOWAH COUNTY	1,000
10. REPUBLIC STEEL CORP.	GADSDEN, ETOWAH COUNTY	4,000
11. MONSANTO CO., INC.	GUNTERSVILLE, MARSHALL COUNTY	1,500
12. CHRYSLER CORP.	HUNTSVILLE, MADISON COUNTY	2,000
13. HUNTSVILLE MANUFACTURING CO., INC.	HUNTSVILLE, MADISON COUNTY	2,000
14. GTE AUTOMATIC ELECTRIC CORP.	HUNTSVILLE, MADISON COUNTY	4,000
15. SCI SYSTEMS, INC.	HUNTSVILLE, MADISON COUNTY	1,000
16. TELEDYNE BROWN ENGINEERING, INC.	HUNTSVILLE, MADISON COUNTY	1,000
17. FORD MOTOR CO.	SHEFFIELD, COLBERT COUNTY	1,500
18. REYNOLDS METALS CO., INC.	SHEFFIELD, COLBERT COUNTY	6,000
19. GC LINGERIE CORP.	TUSCUMBIA, COLBERT COUNTY	1,000

ORIGINAL PAGE IS OF POOR QUALITY

NUMBER OF FACILITIES IN NORTHERN ALABAMA

Industries were grouped into four categories which are prioritized by propensity to consume medium-BTU gas. Rubber, basic metal, and chemical plants would initially be attracted to the utilization of synthetic fuels. Currently petroleum refining, can manufacturing, and benefaction of iron are expansion-type industries in Northern Alabama.

NUMBER OF FACILITIES IN NORTH ALABAMA

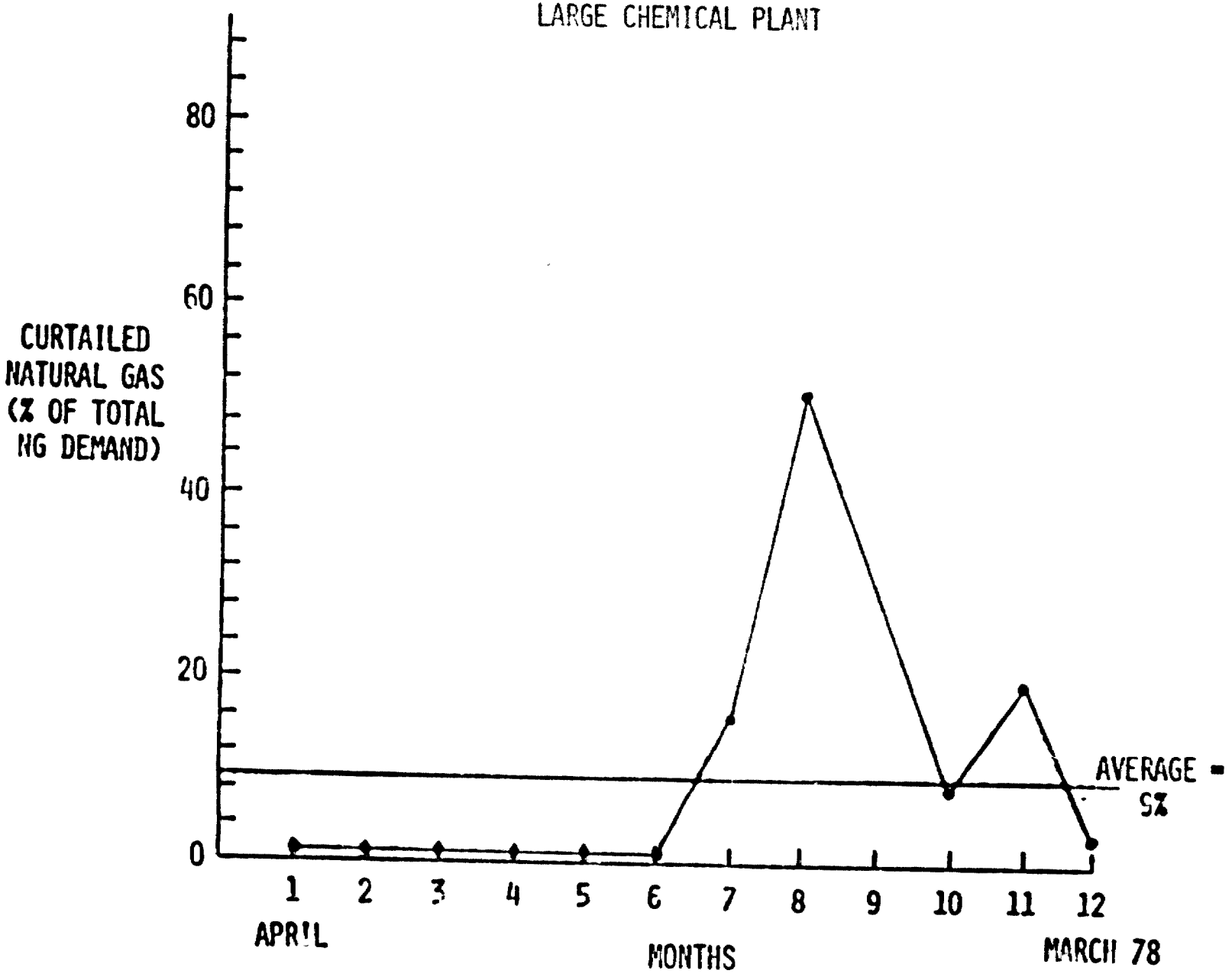
GROUP NUMBER	INDUSTRY TYPE	NUMBER OF FACILITIES LOCATED IN NORTH ALABAMA
I	1. PETROLEUM REFINING*	0
	2. PRODUCTION OF CHEMICALS	25
	3. BASIC STEEL MANUFACTURING	3
II	1. RUBBER PRODUCTION	5
	2. LUMBER AND PULP	22
	3. PAPER	1
	4. FOOD PROCESSING	45
III	1. METAL FABRICATION	77
	2. MANUFACTURE OF ELECTRICAL EQUIPMENT	32
	3. OTHER MANUFACTURED MACHINERY	45
	4. CAN MANUFACTURING*	0
IV	1. NON-FERROUS METAL PRODUCTION	5
	2. BENEFACTION OF IRON ORE*	0
	3. GLASS MAKING	1

NOTE: THERE ARE 93 TEXTILE MILLS AND 51 CONCRETE PLANTS IN NORTH ALABAMA

*GROWTH INDUSTRIES

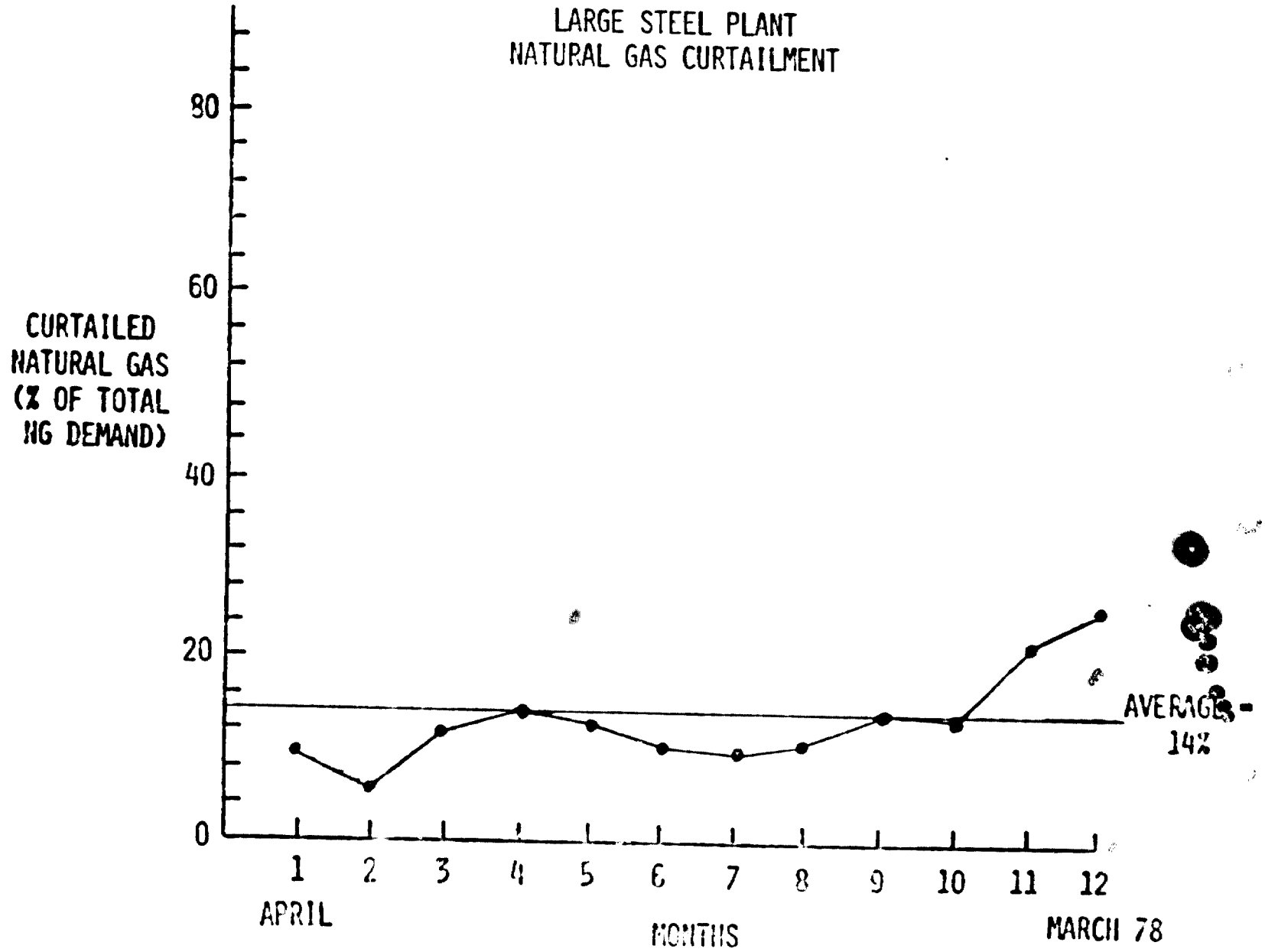
LARGE CHEMICAL PLANT CURTAILMENT

Data obtained from a large chemical plant illustrates the curtailment of natural gas industries are presently undergoing. This plant was curtailed an average of 9% normal natural gas useage over a year's period, with some winter months being greater than 50%.


LARGE CHEMICAL PLANT
CURTAILED NATURAL GAS (% OF TOTAL NG DEMAND)
80
60
40
20
0
AVERAGE = 5%
1
2
3
4
5
6
7
8
9
10
11
12
APRIL
MONTHS
MARCH 78

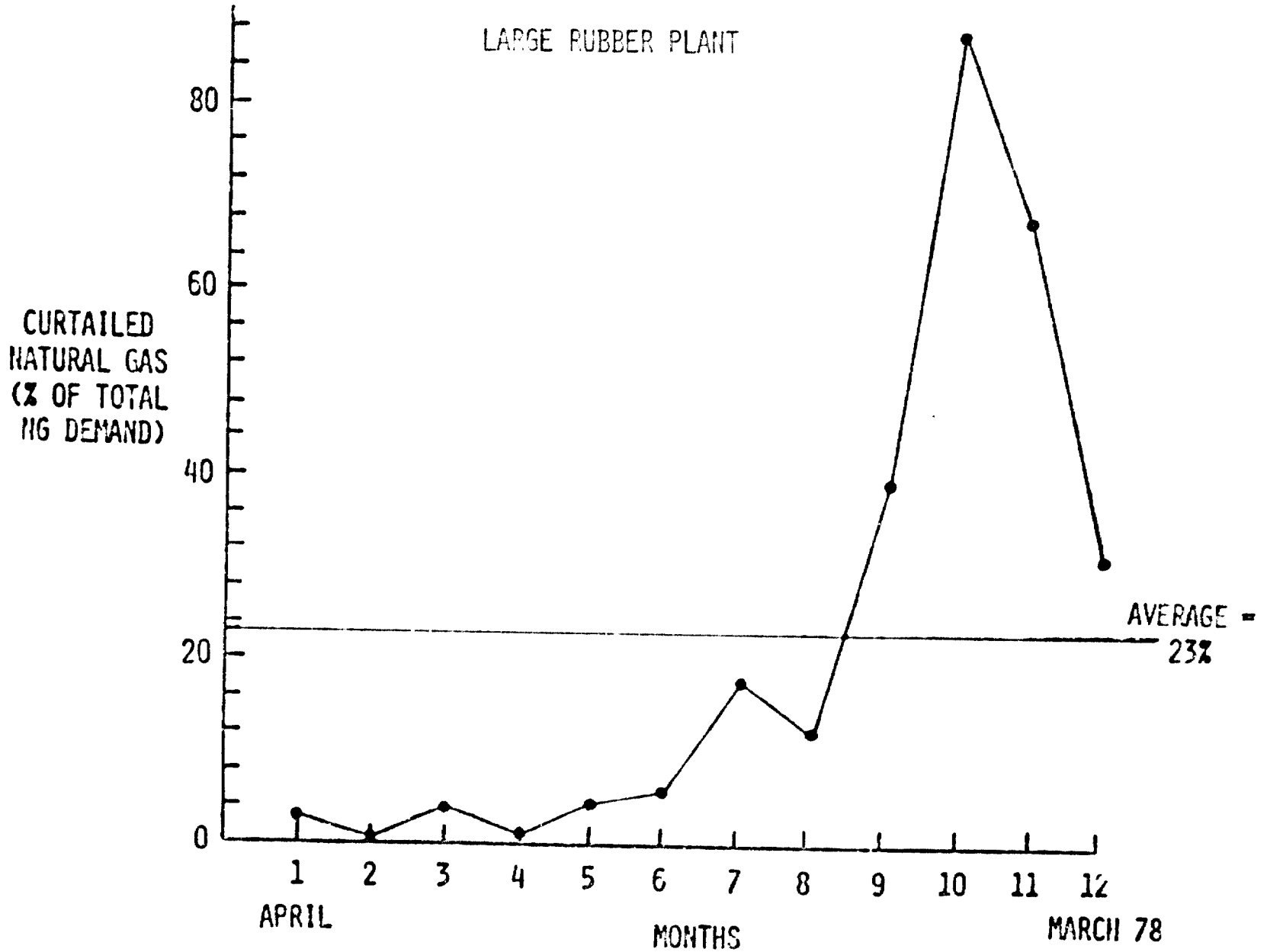
LARGE STEEL PLANT NATURAL GAS CURTAILMENT

To illustrate another type of industrial natural gas curtailment, actual data from a large steel plant is shown. The average yearly curtailment is 14%, with small monthly variations. However, the particular steel plant shown is the largest energy consumer in the region under consideration.


LARGE STEEL PLANT
NATURAL GAS CURTAILMENT
CURTAILED NATURAL GAS (% OF TOTAL NG DEMAND)
80
60
40
20
0
AVERAGE - 14%
1
2
3
4
5
6
7
8
9
10
11
12
APRIL
MONTHS
MARCH 78

LARGE RUBBER ANT NATURAL GAS CURTAILMENT

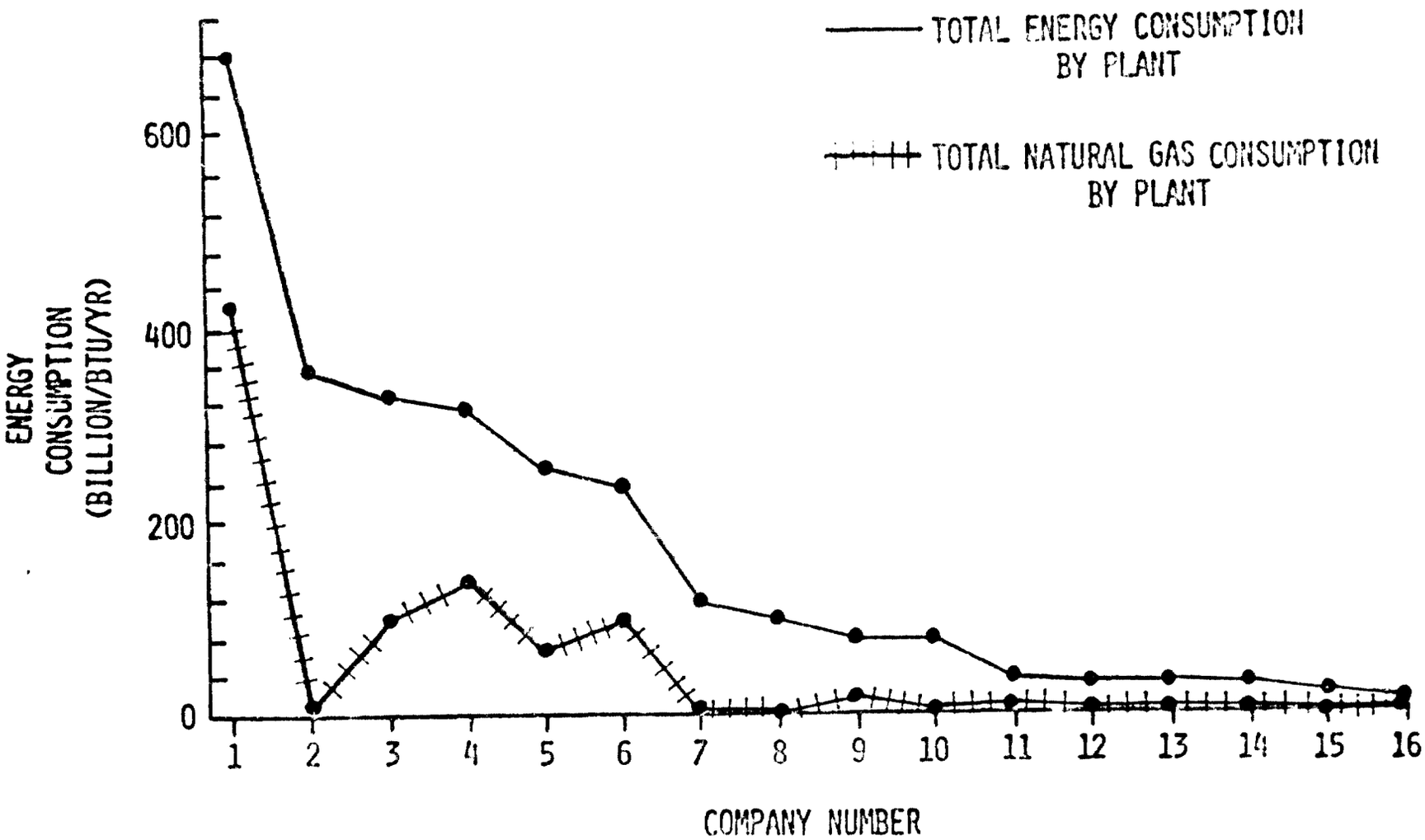
The figure illustrates that natural gas curtailment was greater than 80% for a rubber plant in Northern Alabama during the winter months. The average curtailment was almost one quarter. In general, plants used fuel oil when natural gas was curtailed.


LARGE RUBBER PLANT
CURTAILED NATURAL GAS (% OF TOTAL NG DEMAND)
80
60
40
20
0
AVERAGE = 23%
1
2
3
4
5
6
7
8
9
10
11
12
APRIL
MONTHS
MARCH 78

HU VILLE LOAD CENTER

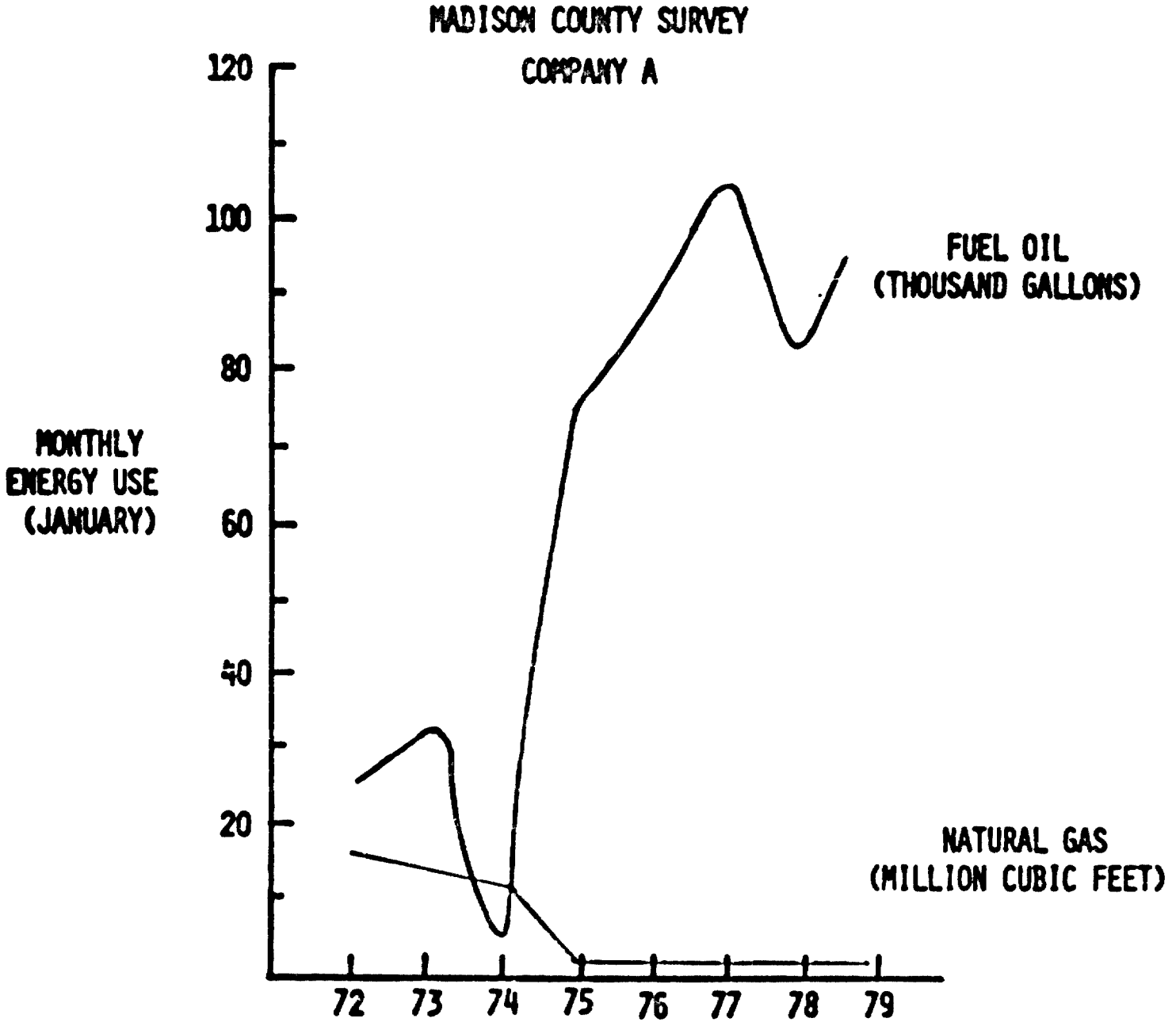
From the sixteen survey replies which were received, it was quantitatively obvious that no very large energy users were in this area. A "large" energy user was defined as one which consumed more than 1,000 billion (one trillion) BTU's per year.

HUNTSVILLE LOAD CENTER



MONTHLY ENERGY USE FOR JANUARY

This chart illustrates how the companies have responded to the forced curtailment of their natural gas supply. They have made a massive shift to fuel oil during those winter months when residential consumers have priority on the supply.

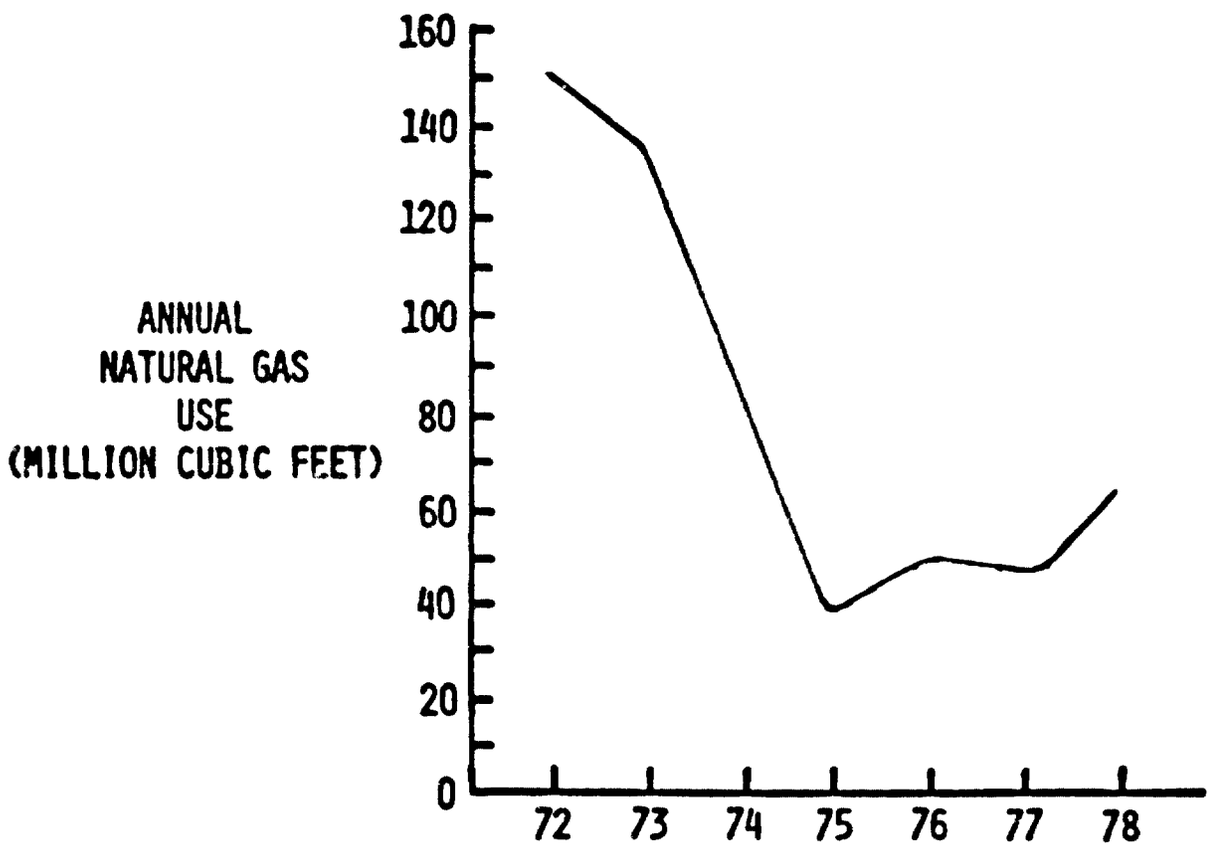

MADISON COUNTY SURVEY
COMPANY A
MONTHLY
ENERGY USE
(JANUARY)
120
100
80
60
40
20
72
73
74
75
76
77
78
79
FUEL OIL
(THOUSAND GALLONS)
NATURAL GAS
(MILLION CUBIC FEET)

ANNUAL NATURAL GAS USEAGE

For several years, the amount of natural gas available to the large industrial users has been falling. It appears to have temporarily leveled off. Imported natural gas from Mexico and Canada is increasing in supply and price.

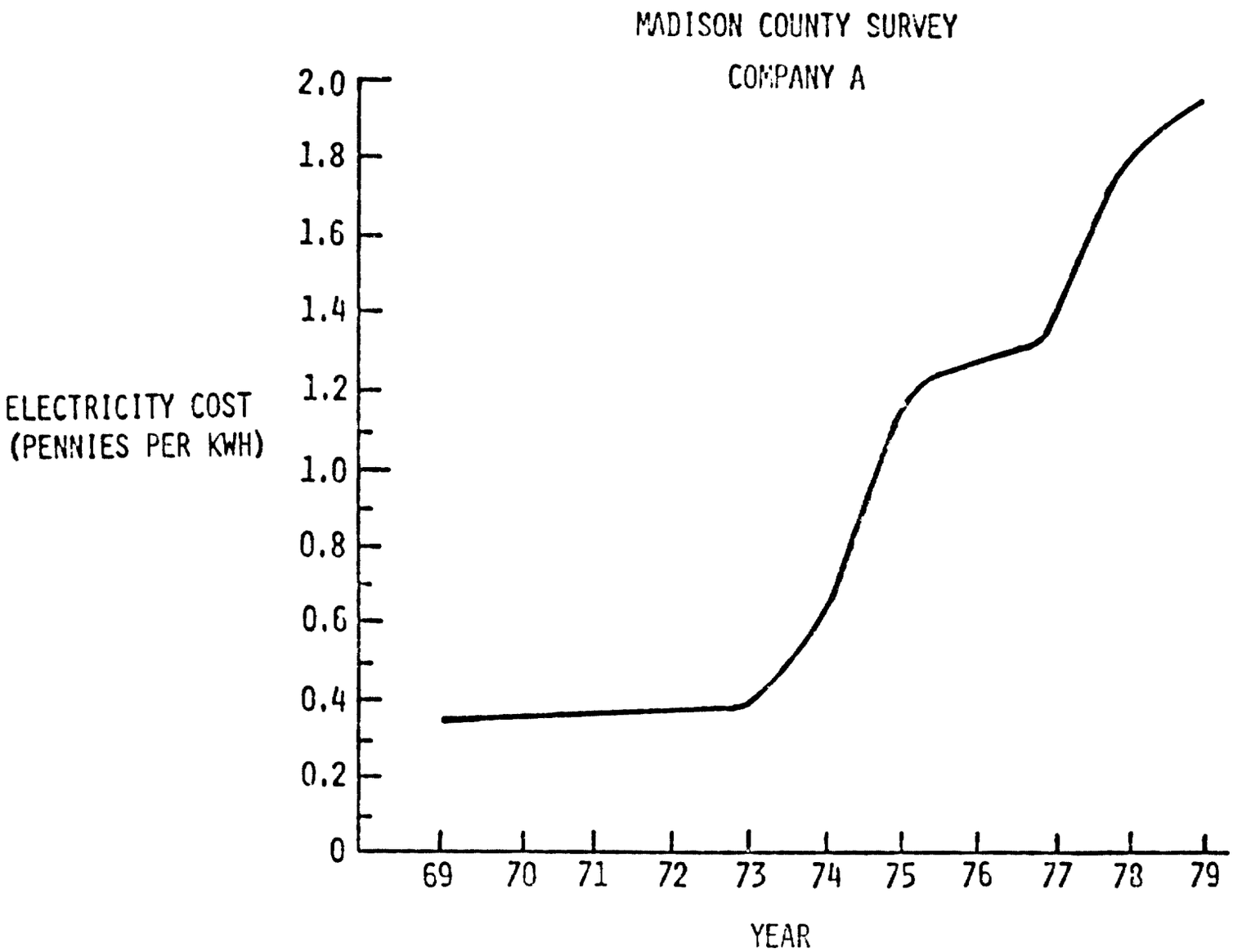
MADISON COUNTY SURVEY

COMPANY A



ELECTRICAL USEAGE

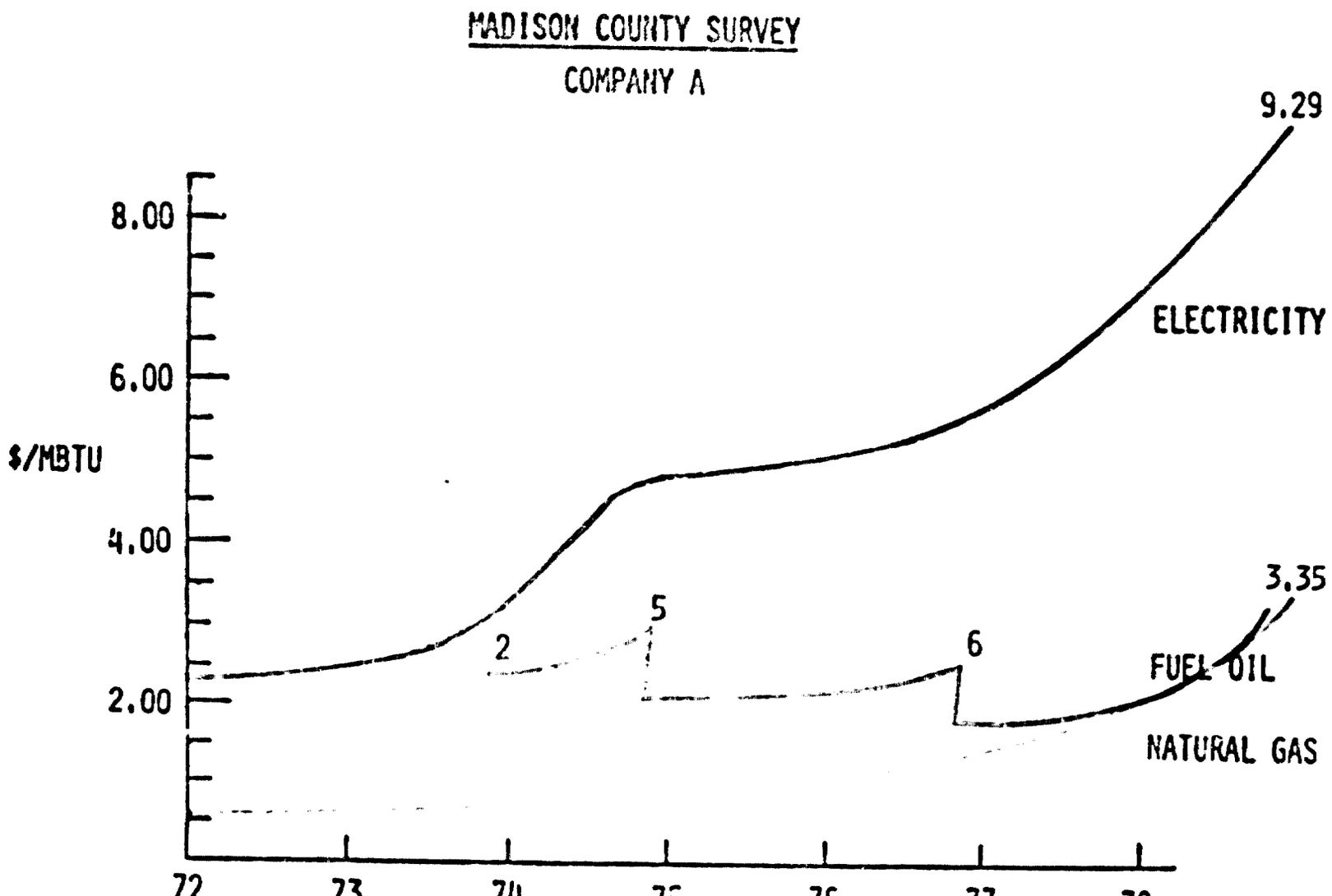
Many industries are changing to electrical useage because of surety of supply and cleanliness of emissions. Demand for electricity has been rising as well as the price.


MADISON COUNTY SURVEY
COMPANY A
ELECTRICITY COST
(PENNIES PER KWH)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
69
70
71
72
73
74
75
76
77
78
79
YEAR

FUEL PRICES

This chart is illustrative of the general industrial situation. When this company's natural gas was forcefully curtailed, it switched to #2 fuel oil. As the price of this high-grade fuel oil increased, the company switched to lower grades, namely #5 and then #6. Now the company is faced with escalating prices for #6 fuel oil.

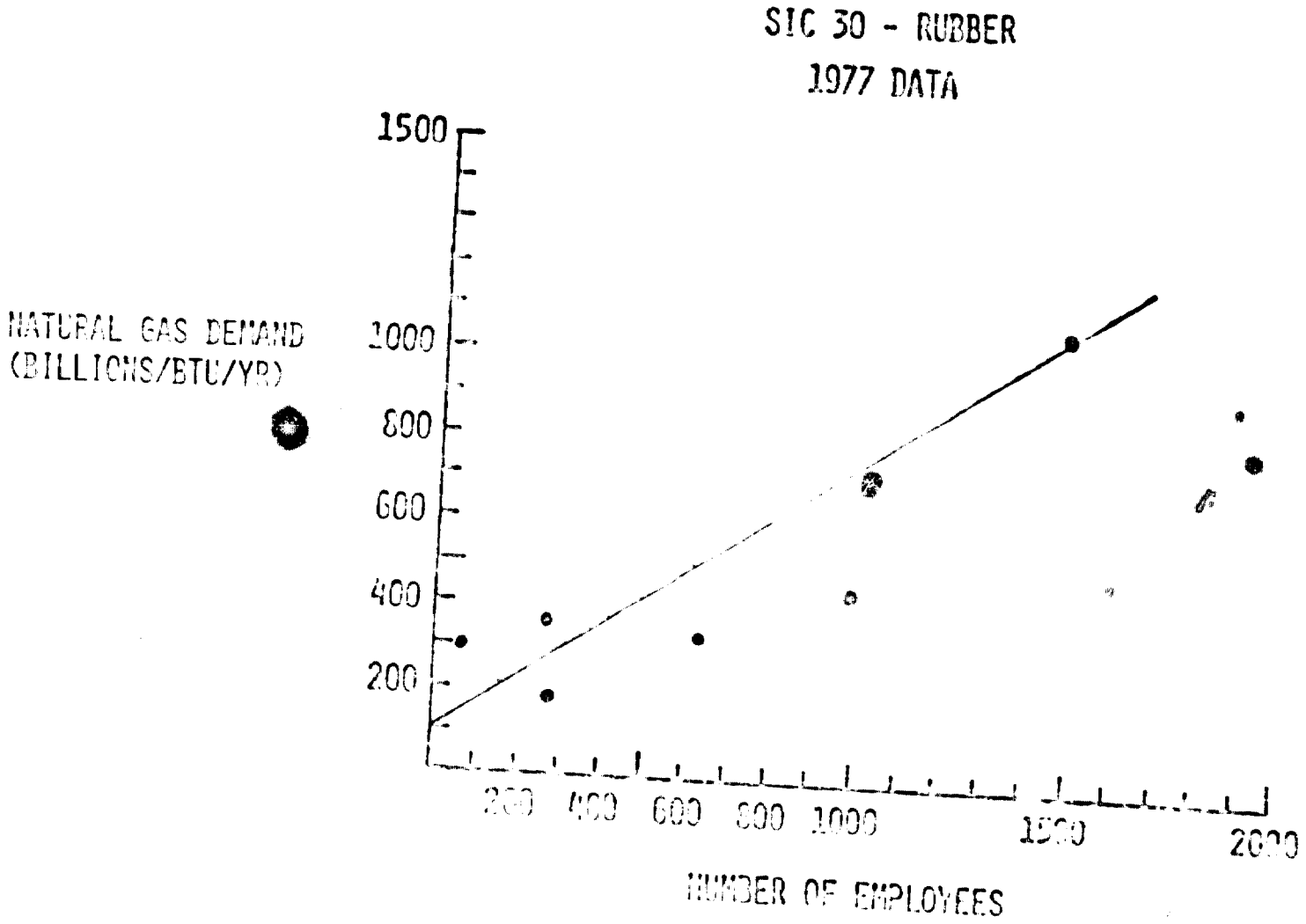
This chart also illustrates that the current prices of #6 fuel oil and natural gas are about the same. This fact illustrates once again that the company, which would infinitely prefer natural gas to fuel oil, has been forcefully made to switch to fuel oil.


MADISON COUNTY SURVEY
COMPANY A
9.29
8.00
6.00
$/MBTU
4.00
2.00
ELECTRICITY
3.35
5
2
6
FUEL OIL
NATURAL GAS
72
73
74
75
76
77
78

CORRELATION OF NATURAL GAS CONSUMPTION WITH NUMBER OF EMPLOYEES

Since it was not possible to obtain actual energy consumption data from all major industries in the region under study, estimates of natural gas demand were necessary. Actual natural gas demand (includes fuel oil) versus number of employees was plotted for each type of industry. Linear correlations of employees versus natural gas consumption were made. Therefore, knowing the SIC and number of employees from Alabama and Tennessee industrial manuals, an estimate can be made.

CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES



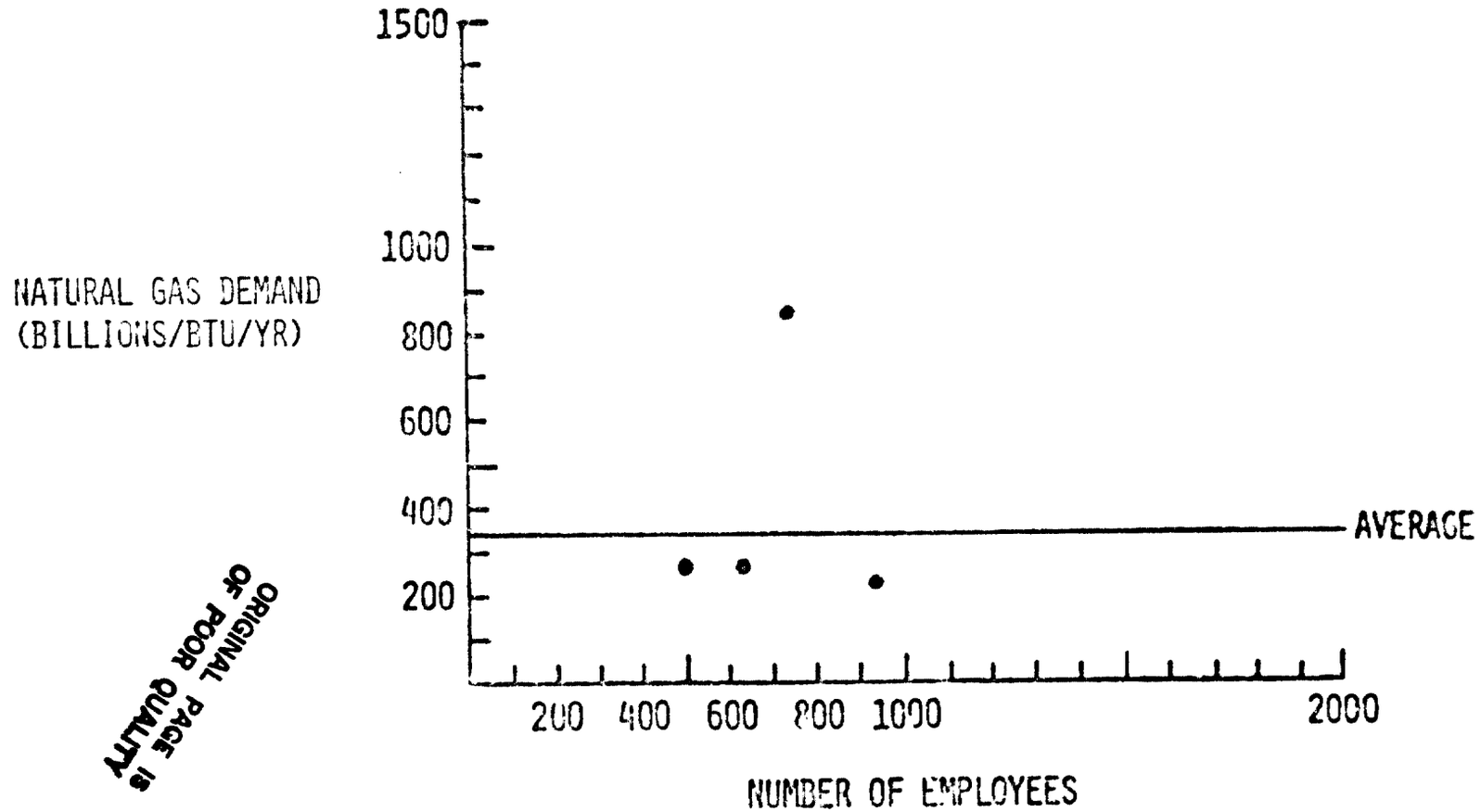
CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES

For the textile industry, there appears to be little correlation of natural gas demand versus employees. An average of 350 BBTU/YR was used in estimating natural gas demand.

CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES

SIC 22 - TEXTILES

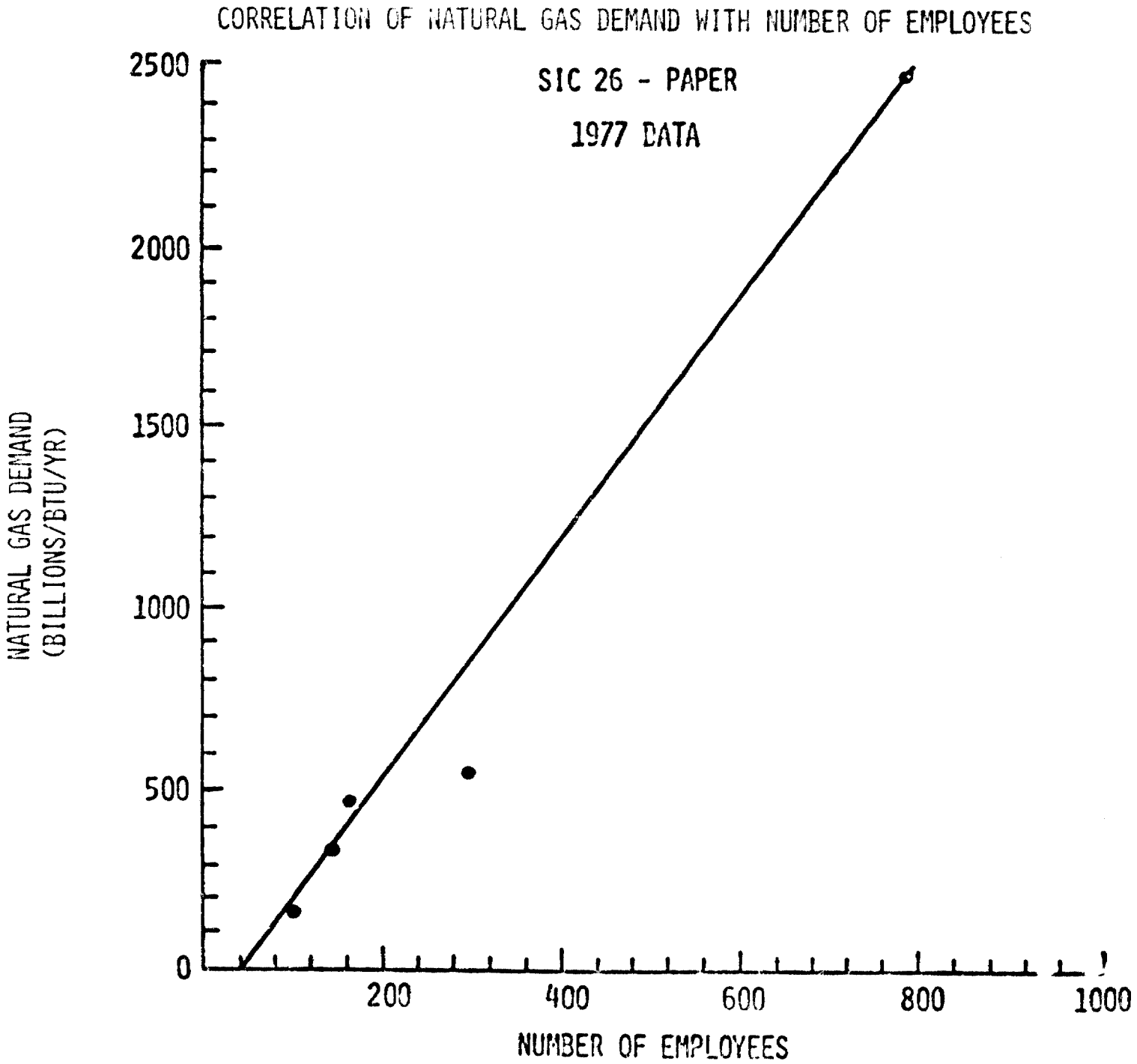
1977 DATA



ORIGINAL PAGE IS
OF POOR QUALITY

CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES

The paper industry natural gas demand data correlates well with the number of employees. Large paper mills also consume greater than 1 trillion BTU/YR. Several large paper mills are located in Northern Alabama and South Central Tennessee.


CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES
SIC 26 - PAPER
1977 DATA
NATURAL GAS DEMAND
(BILLIONS/BTU/YR)
2500
2000
1500
1000
500
0
200
400
600
800
1000
NUMBER OF EMPLOYEES

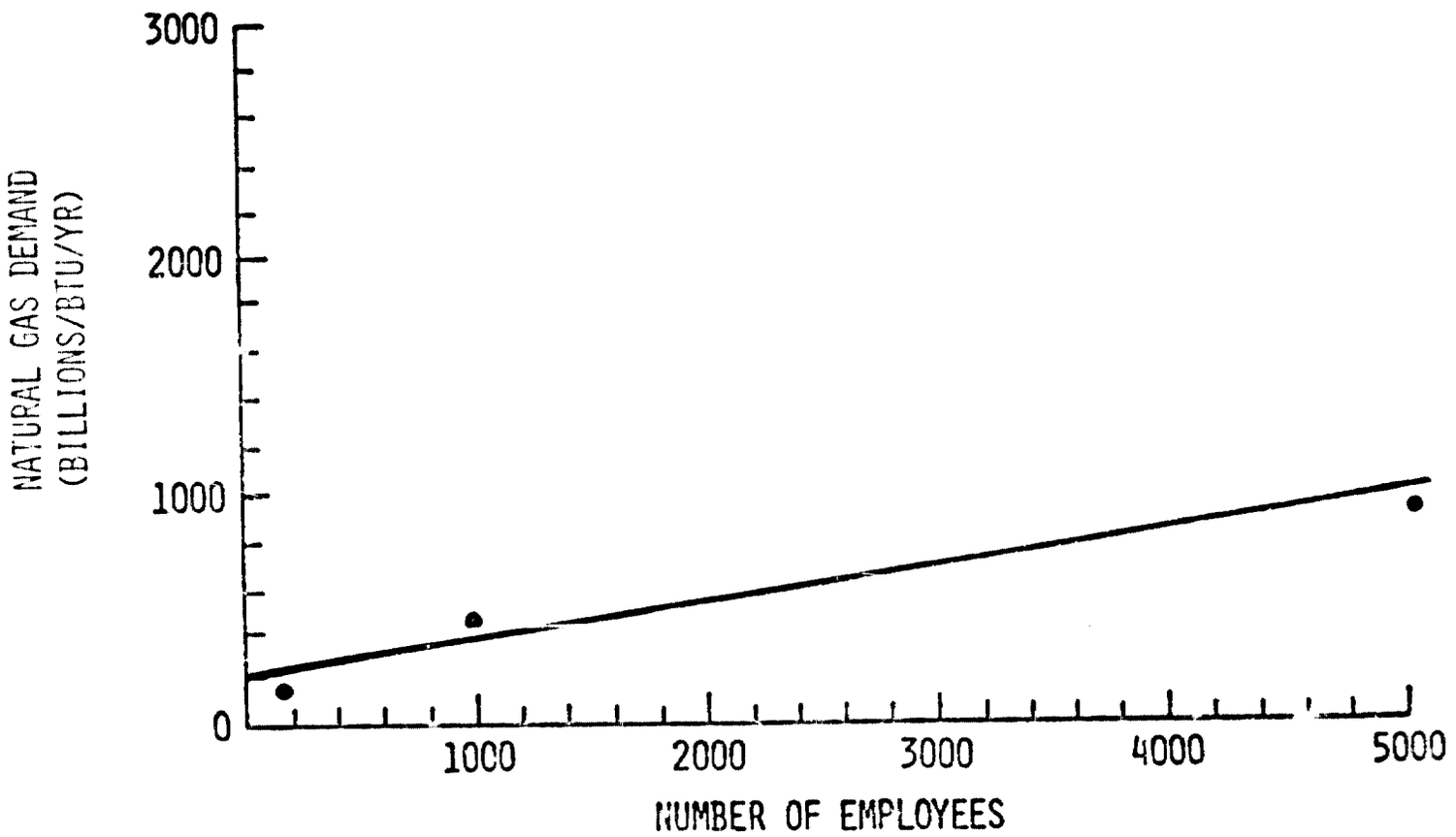
CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES

There were only three data points for the fabricated metals industry. However, the data correlated well with number of employees. The data shows large fabricated metals industries are not big consumers of natural gas and fuel.

CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES

SIC 34 - FABRICATED METALS

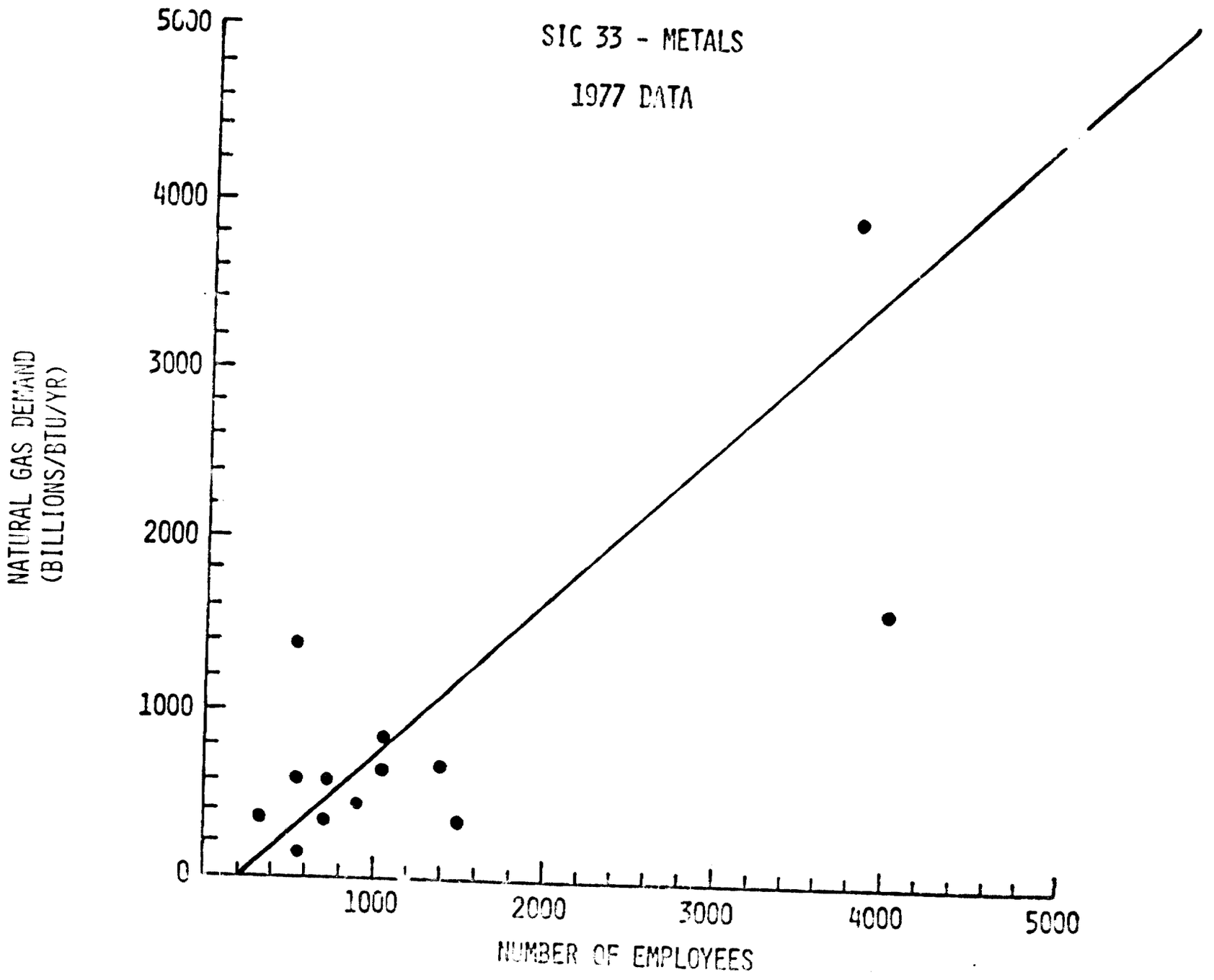
1977 DATA



CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES

The primary metals industry is a large consumer of natural gas and fuel oil. Correlation of energy with employees is fairly good for under 1,000 employees.

CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES



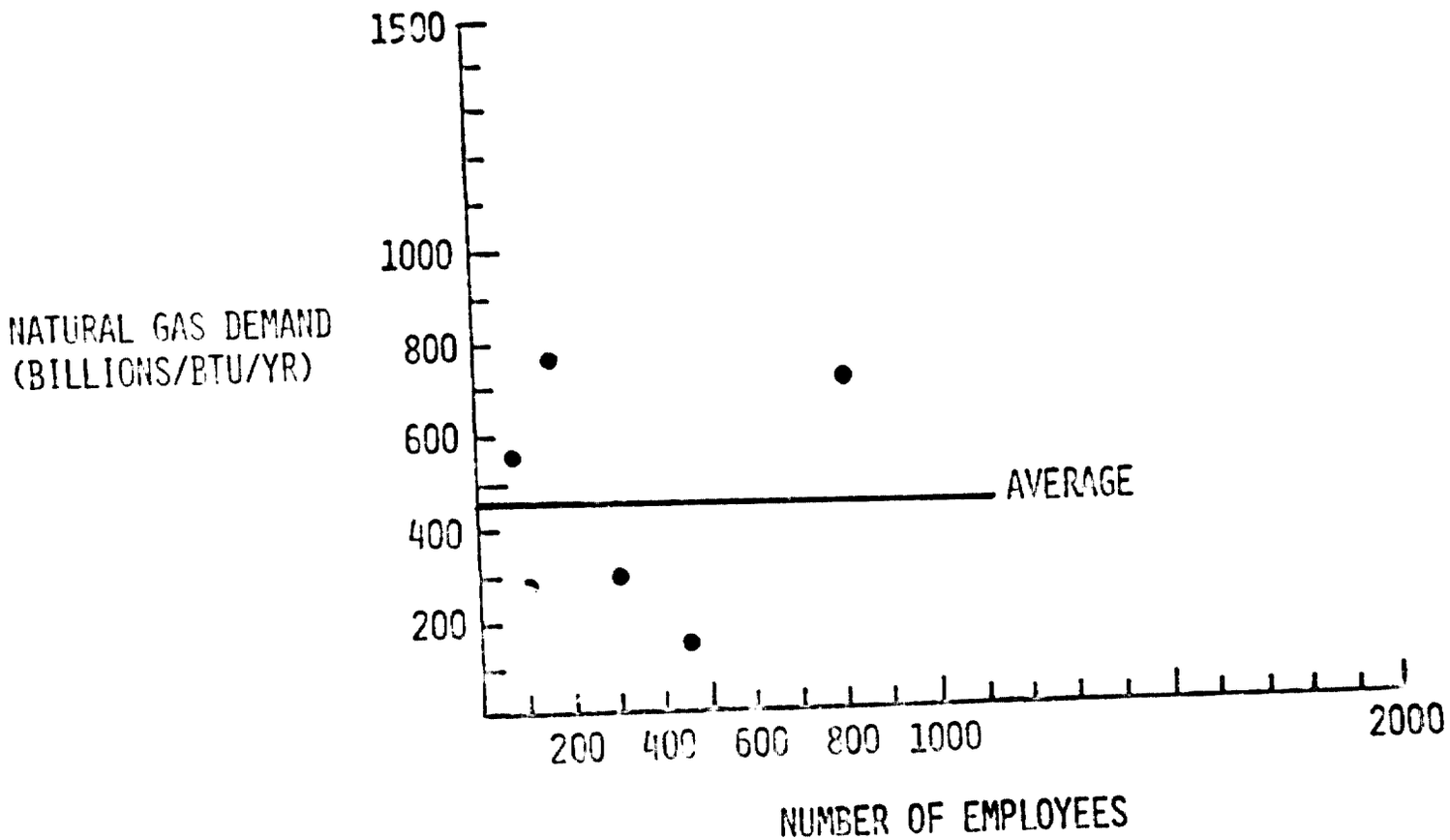
CORRELATION OF NATURAL GAS DEMAND WITH NUMBER O. EMPLOYEES

The food industry is not a large consumer of natural gas and fuel oil. An average of 460 BBTU/YR was used for estimating purposes.

CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES

SIC 20 - FOOD

1977 DATA



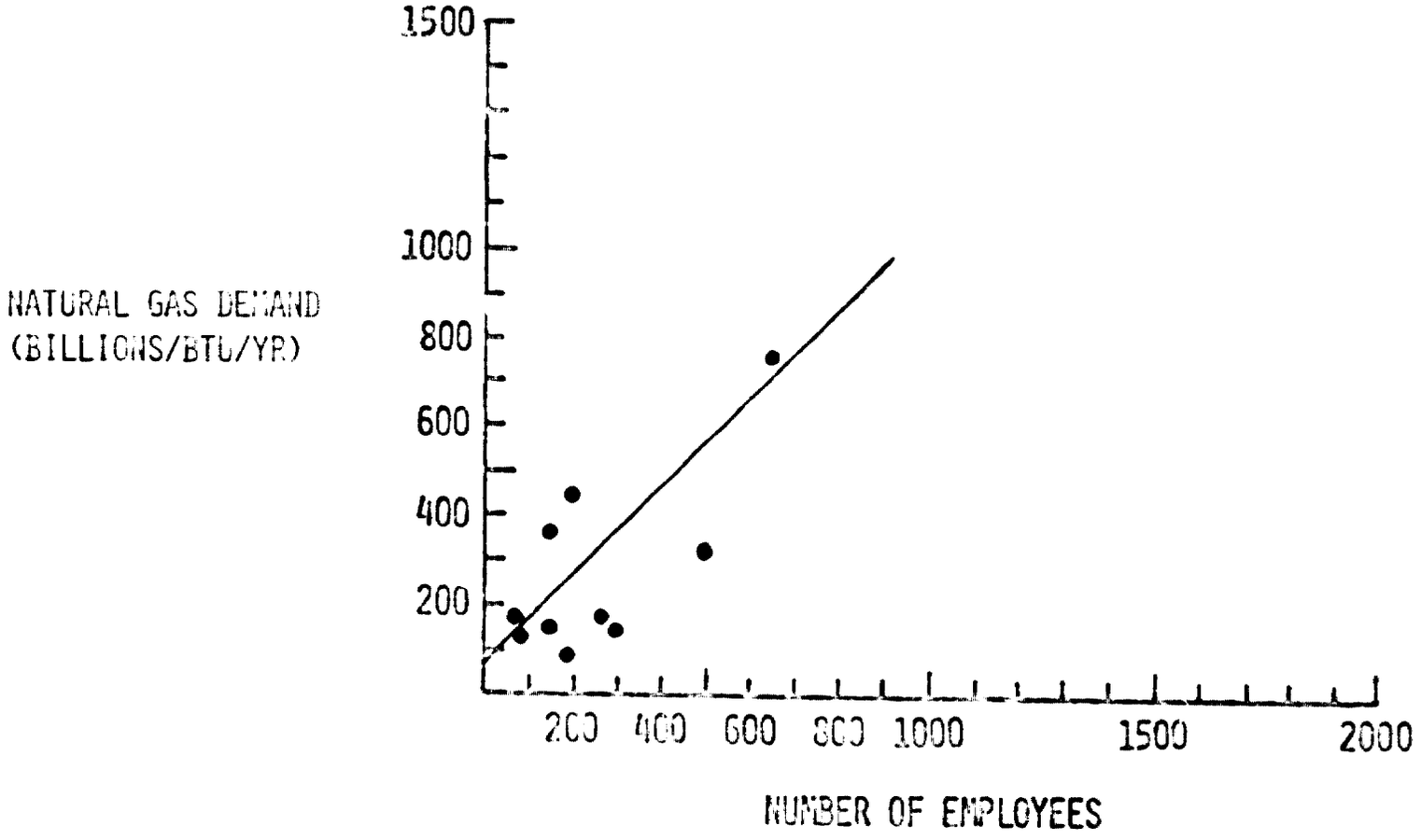
CO: LATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES

Stone/glass industries are fairly numerous in the region under consideration. Natural gas demand correlates well with number of employees.

CORRELATION OF NATURAL GAS DEMAND WITH NUMBER OF EMPLOYEES

SIC 32 - STONE/GLASS

1977 DATA



MAJOR ELECTRICAL CONSUMING INDUSTRIES IN ALABAMA, TENNESSEE, AND MISSISSIPPI

TVA direct sales of electrical energy to large industries (7.9 trillion BTU/YR) in the region are illustrated. Aluminum industries consume the largest amounts of electricity. Chemical and paper industries also consume large amounts of electricity. Direct electrical sales to the federal government were also significant, amounting to 56.9 trillion BTU/YR.

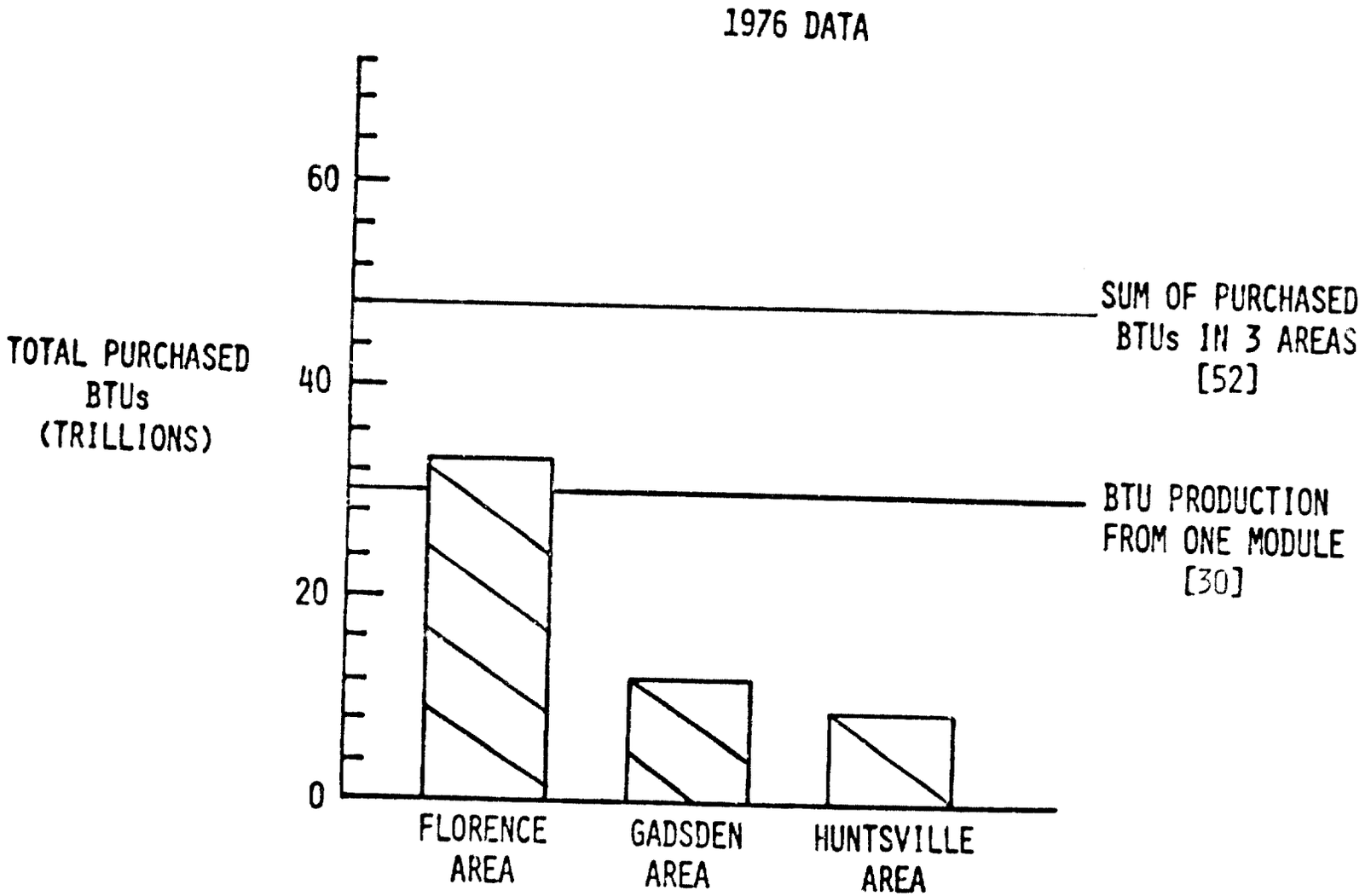
MAJOR ELECTRICAL CONSUMING INDUSTRIES IN ALABAMA, TENNESSEE, AND MISSISSIPPI (1978)*

INDUSTRY	LOCATION	TVA DIRECT SALES AMOUNT ($\times 10^{12}$ BTU/YR)
ALUMINUM CO. OF AMERICA	ALCOA, TN	7.2
AMOCO CHEMICALS	DECATUR, AL	2.6
BOWATER SOUTHERN PAPER	CALHOUN, TN	2.1
CHAMPION PAPER	COURTLAND, AL	0.9
CONSOLIDATED ALUMINUM	JOHNSONVILLE, TN	6.6
DIAMOND SHAMROCK	MUSCLE SHOALS, AL	1.3
ENGLEHARD MINERALS & CHEMICALS	ROCKWOOD, TN	1.2
HOOKER CHEMICALS	COLUMBUS, MS	1.4
HOOKER PHOSPHORUS	COLUMBIA, TN	2.0
INTERNATIONAL MINERALS	BRIDGEPORT, AL	1.1
KERR-McGEE CHEMICAL	HAMILTON, MS	1.9
MONSANTO PHOSPHORUS	COLUMBIA, TN	4.1
MONSANTO TEXTILES	DECATUR, AL	2.1
OLIN	CHARLESTON, TN	2.7
REVERE COPPER & BRASS	SCOTTSBORO, AL	6.5
REYNOLDS ALLOYS	SHEFFIELD, AL	1.5
REYNOLDS REDUCTION	SHEFFIELD, AL	12.1
STAUFFER CHEMICAL	MT. PLEASANT, TN	1.7
TENNESSEE PULP & PAPER	COUNCE, TN	0.9
UNION CARBIDE - CARBON	COLUMBIA, TN	1.1
UNION CARBIDE - METALS	SHEFFIELD, AL	1.4
TOTAL INDUSTRY DIRECT SALES		77.8
TOTAL FEDERAL GOVERNMENT SALES		56.9

* Economics using 0.9×10^{12} BTU/YR Electrical

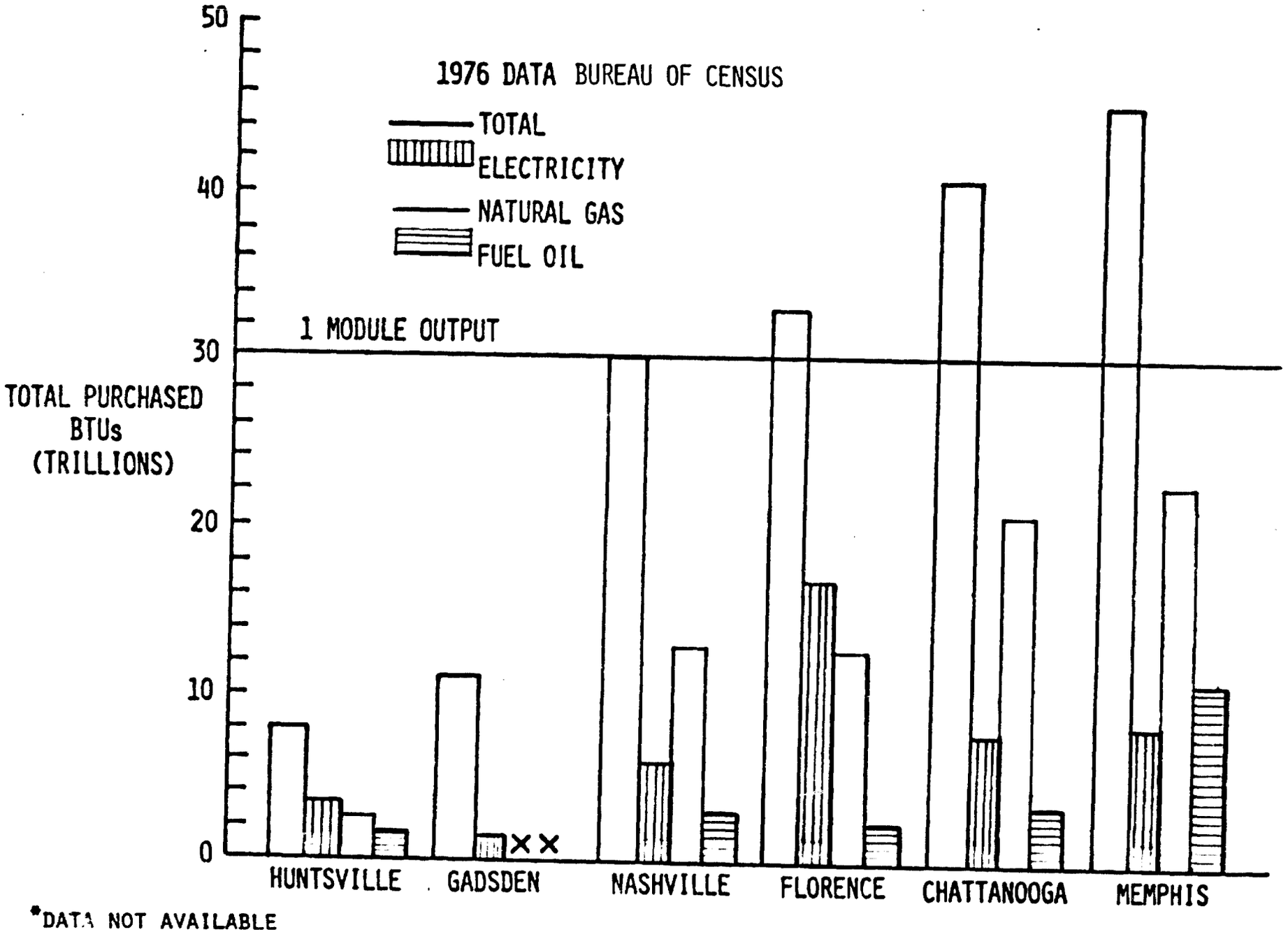
IND TRIAL ENERGY USEAGE

Total purchased energy (natural gas, fuel oil, and electrical) in the Northern Alabama area in 1976 amounted to about 52 trillion BTU's. Huntsville is the smallest energy consumer. The Florence area approximately equals the output of one mode of the coal gasification facility.


1976 DATA
TOTAL PURCHASED BTUs (TRILLIONS)
60
40
20
0
SUM OF PURCHASED BTUs IN 3 AREAS [52]
BTU PRODUCTION FROM ONE MODULE [30]
FLORENCE AREA
GADSDEN AREA
HUNTSVILLE AREA

HISTORICAL 1976 DATA - WITHOUT BIRMINGHAM

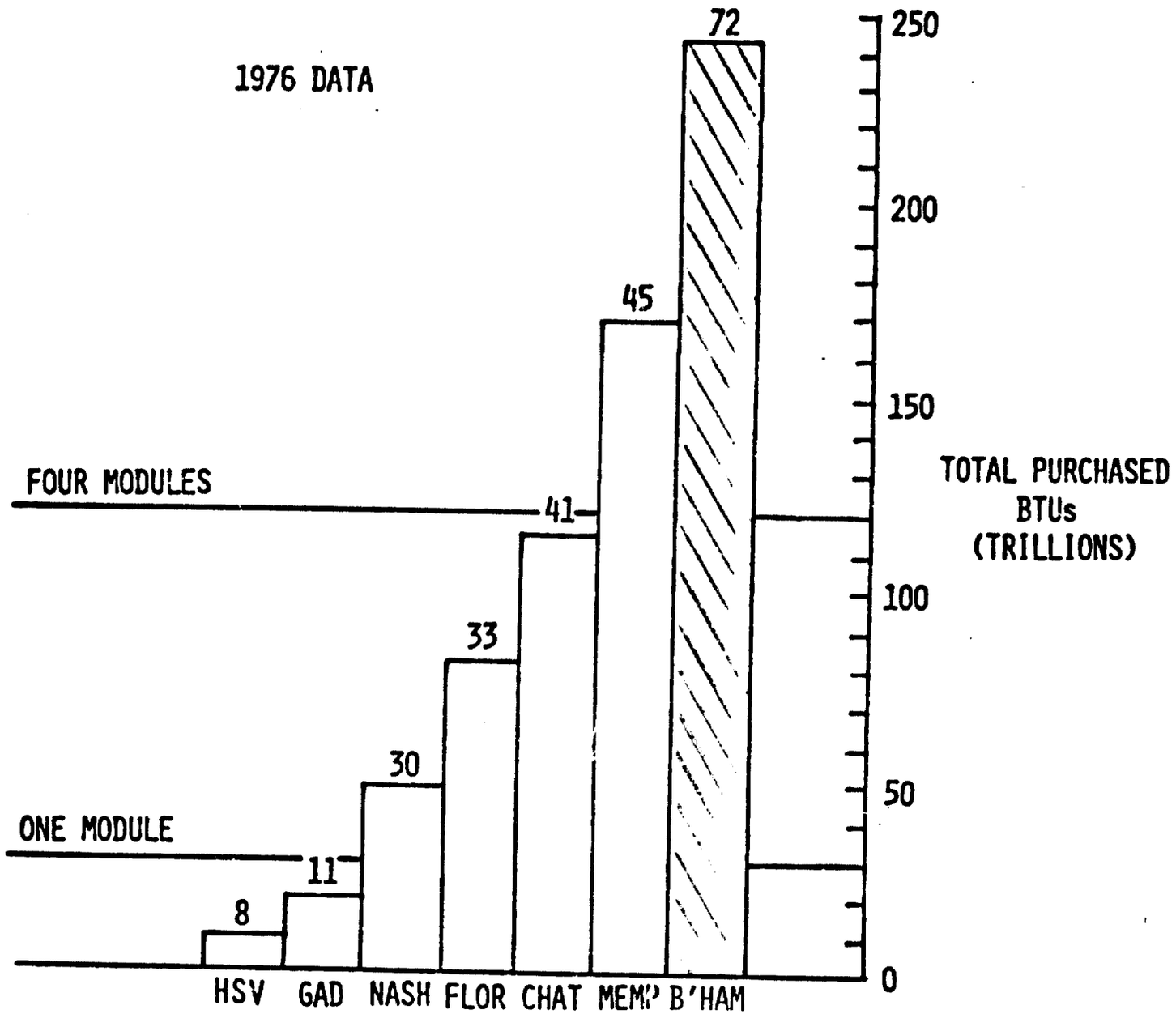
This figure demonstrates that the projected MBG output from just one module of the proposed coal gasification plant is significantly greater, in terms of BTU's, than the 1976 natural gas consumption in any of the major load centers in the region, excluding Birmingham.



*DATA NOT AVAILABLE

HISTORICAL 1976 DATA - WITH BIRMINGHAM

Individual total industrial purchased energy is shown as well as the cummulative comparison to modules. This chart illustrates the large contribution of the Birmingham load center to the total industrial energy consumption in the region. The energy consumption consists of natural gas, fuel oil, and electricity. In 1976, for example, Birmingham alone contributed 72 trillion BTU's to a regional total comparison of 245 trillion BTU's.


1976 DATA
72
45
41
33
30
11
8
FOUR MODULES
ONE MODULE
250
200
150
100
50
0
TOTAL PURCHASED
BTUs
(TRILLIONS)
HSV
GAD
NASH
FLOR
CHAT
MEM?
B'HAM

SECTION 3. PROJECTED INDUSTRIAL GROWTH

PROJECTED INDUSTRIAL GROWTH

Projected industrial growth data in the TVA region through 1990 was assessed in this section. Industrial growth and energy useage are closely correlated. Industries will not locate in a region unless there is an assured supply of energy. This report does not address the impact of a large coal gasification plant on industrial growth. Industrial growth and energy projections are based primarily on econometric models at TVA, the University of Tennessee, and the Oak Ridge National Labs. Historical and linear projections were also incorporated into the analysis.

PROJECTED INDUSTRIAL GROWTH

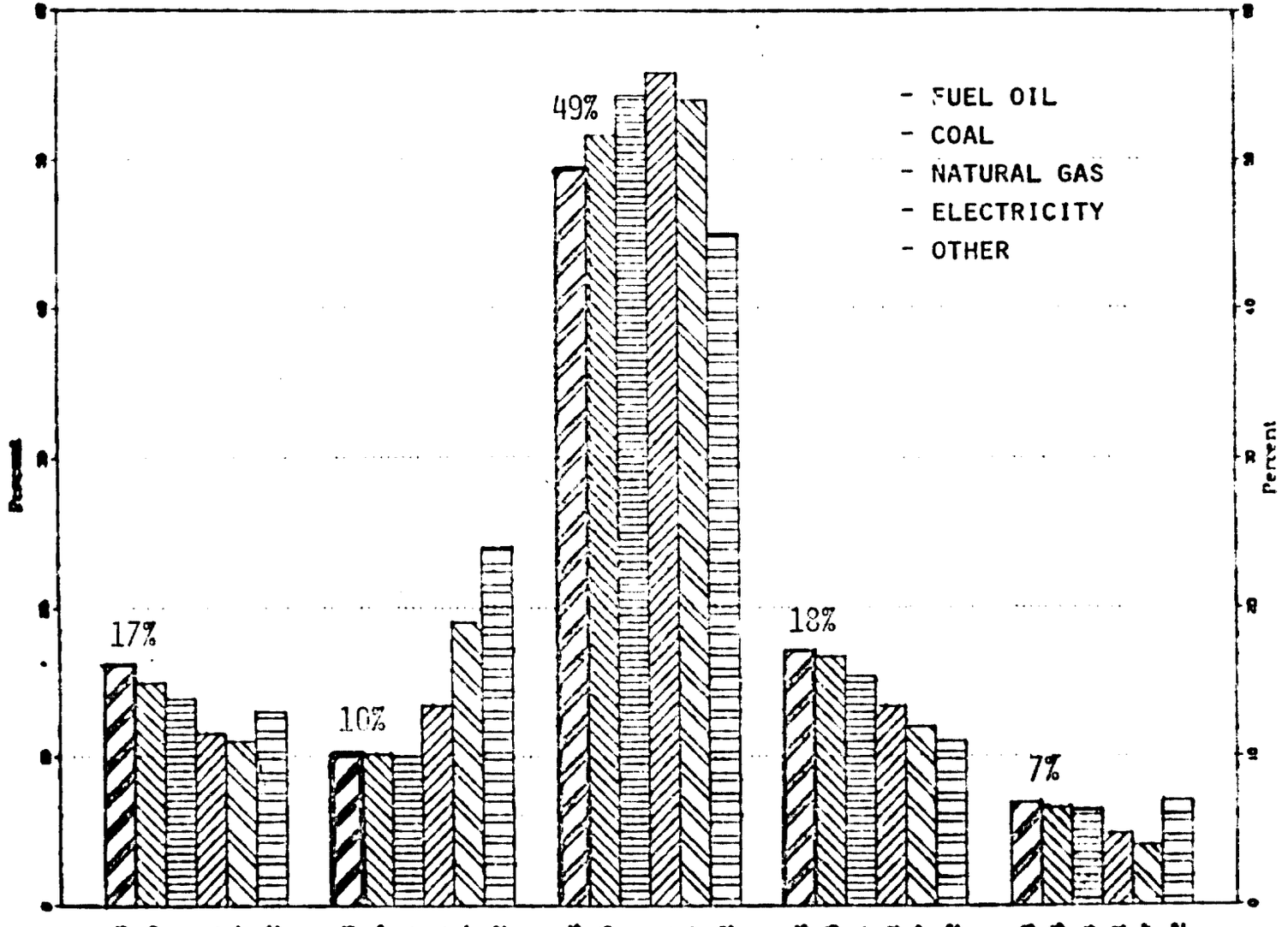
- CURRENT INDUSTRY CATEGORIES
- REGIONAL RESOURCES
- HISTORICAL GROWTH DATA
- TVA & ORNL PROJECTED GROWTH DATA
- LINEAR PROJECTIONS
- QUANTIFY SYNTHETIC FUELS IMPACT ON ECONOMIC DEVELOPMENT

NATIONWIDE INDUSTRIAL ENERGY GROWTH

Industrial energy growth has been relatively stable or declining in the recent past due to rising prices, curtailments, and conservation. Fuel oil useage has been rising due to natural gas curtailments. Coal has been declining due to pollution restrictions. Natural gas demand remains high, but industrial useage has been drastically curtailed during winter months. Purchased electricity has been rising, since it is a sure supply; however, prices are also rising. Other purchased fuels (coke, propane, LNG) are rising slightly because of natural gas substitutes.

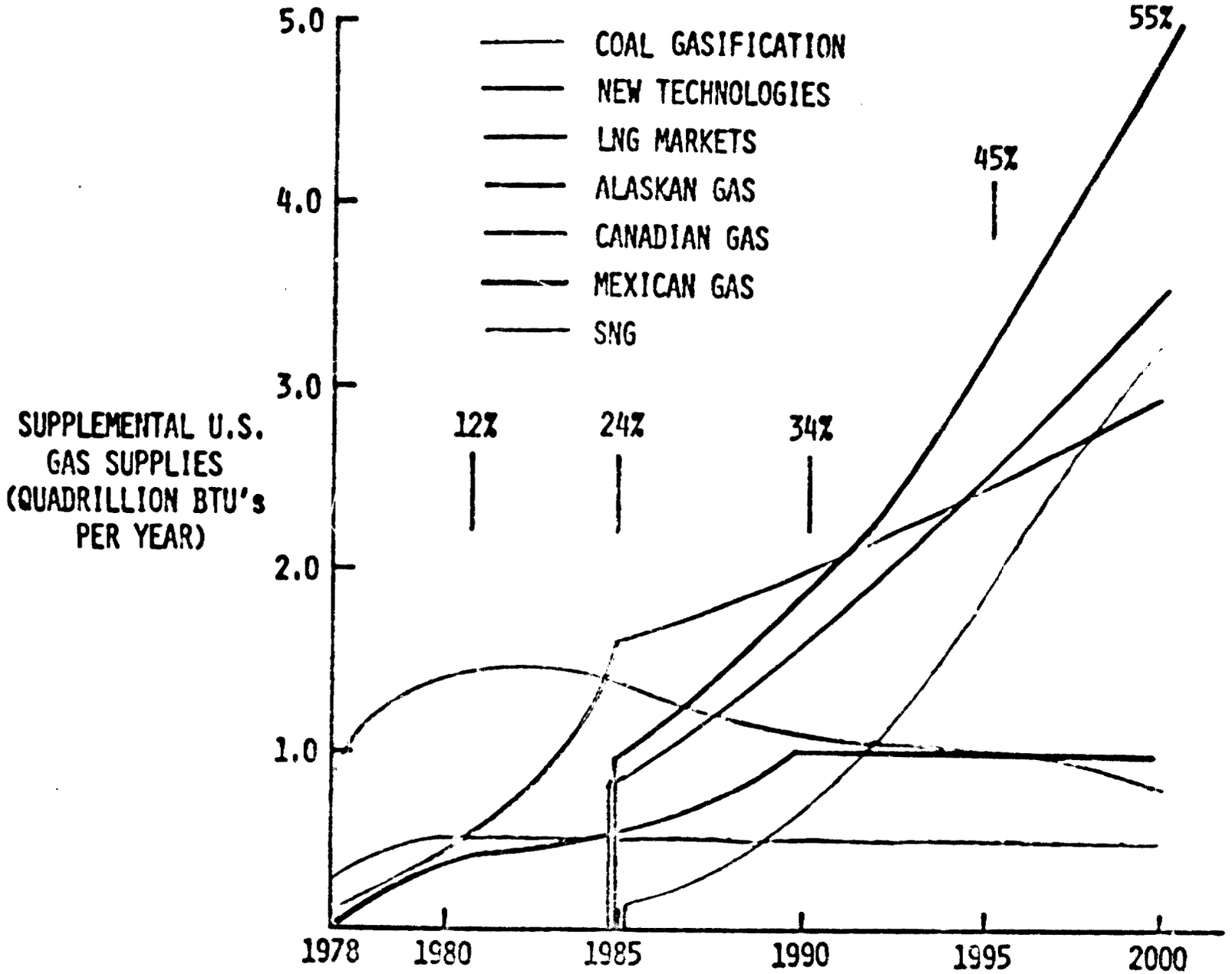
ORIGINAL PAGE IS
OF POOR QUALITY

NATIONWIDE INDUSTRIAL ENERGY GROWTH



PROJECTED GAS SUPPLIES

Natural gas supply in the future is a very controversial subject. U.S. reserves, deregulation of prices, imports, and reserves in the Gulf are all speculative. The American Gas Association provided optimistic scenarios (1979), as shown on the facing page. Coal gasification and new technologies are expected to supplement current U.S. supplies and imports.

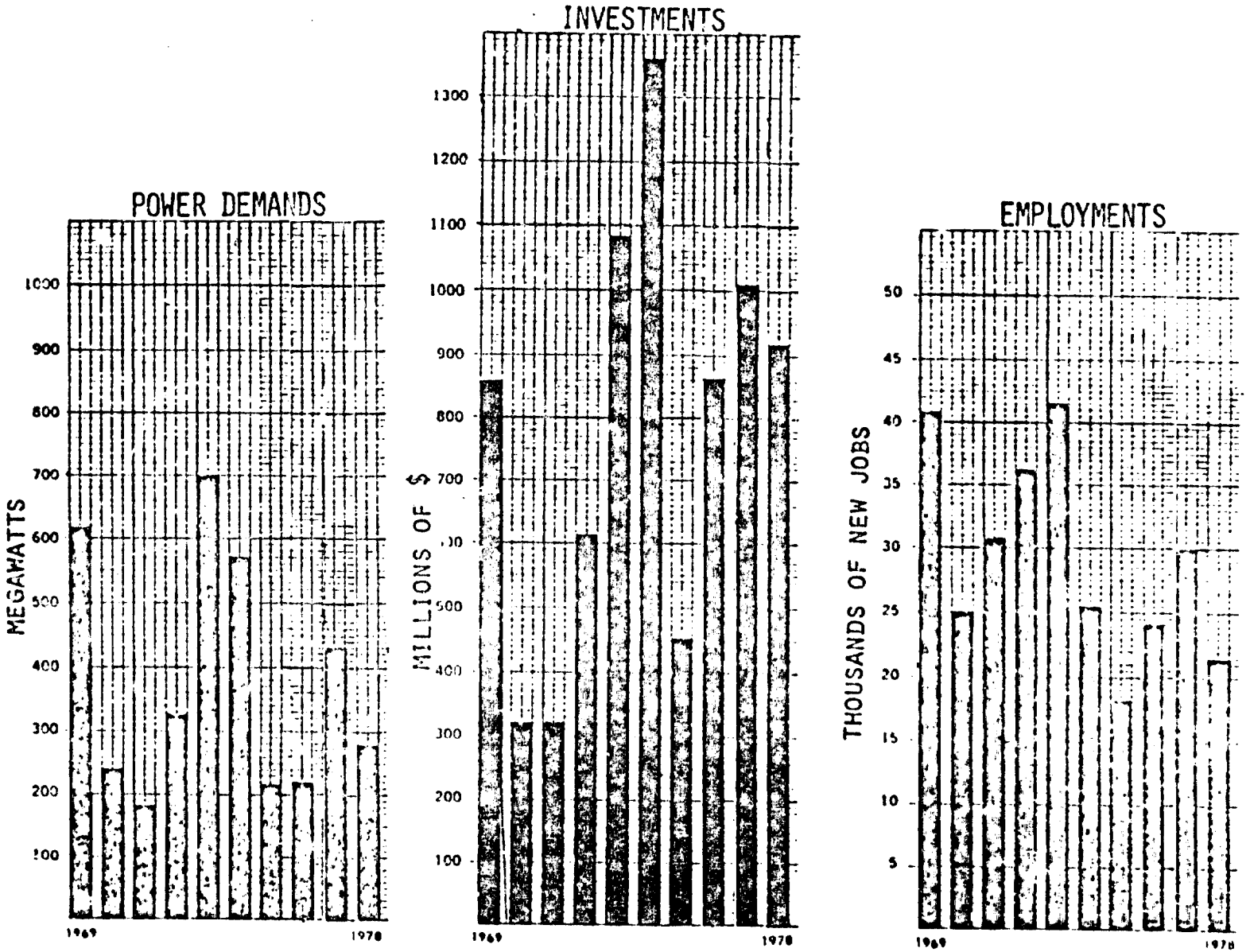

SUPPLEMENTAL U.S. GAS SUPPLIES (QUADRILLION BTU's PER YEAR)
5.0
4.0
3.0
2.0
1.0
COAL GASIFICATION
NEW TECHNOLOGIES
LNG MARKETS
ALASKAN GAS
CANADIAN GAS
MEXICAN GAS
SNG
12%
24%
34%
45%
55%
1978
1980
1985
1990
1995
2000

INDUSTRIAL DEVELOPMENT IN THE TVA AREA DURING RECENT YEARS

In the TVA region, industrial growth has been significant during recent years due to availability of power, land, water, and labor. An average of over 20,000 new jobs are provided annually in the TVA region.

INDUSTRIAL DEVELOPMENT IN THE TVA AREA DURING RECENT CALENDAR YEARS

(INCLUDES BOTH REPORTED AND STATISTICALLY ESTIMATED DATA)



ORIGINAL PAGE IS
OF POOR QUALITY

AVERAGE ANNUAL PERCENTAGE GROWTH RATES BY STATE

Near-term energy growth rates in the Southeast are estimated to be less than 3.0 percent for oil and gas. In some states, natural gas is projected to decline. Electricity and coal growths are expected to be consistent.

AVERAGE ANNUAL PERCENTAGE GROWTH RATES IN FINAL ENERGY BY STATE

	Electricity	Coal	Oil	Gas	Total
Alabama	4.3	4.3	1.5	1.5	2.9
Florida	4.3	7.5	2.2	-0.5	1.9
Georgia	4.3	6.0	1.9	-1.1	2.3
Kentucky	4.6	4.6	1.6	0.2	2.8
Louisiana	4.0	4.7	2.8	1.3	2.4
Mississippi	4.0	8.3	1.5	0.3	2.0
N. Carolina	4.4	5.9	1.8	-0.2	2.7
S. Carolina	4.6	6.1	1.9	2.4	3.0
Tennessee	4.5	5.3	1.8	0.9	3.2
Texas	4.0	4.2	2.1	1.5	2.3
Virginia	4.3	5.4	1.7	-0.5	2.6
W. Virginia	4.2	3.8	1.2	-0.3	2.7
Region	4.3	4.7	2.0	1.0	2.6
Nation	4.4	3.4	1.6	-0.2	2.1

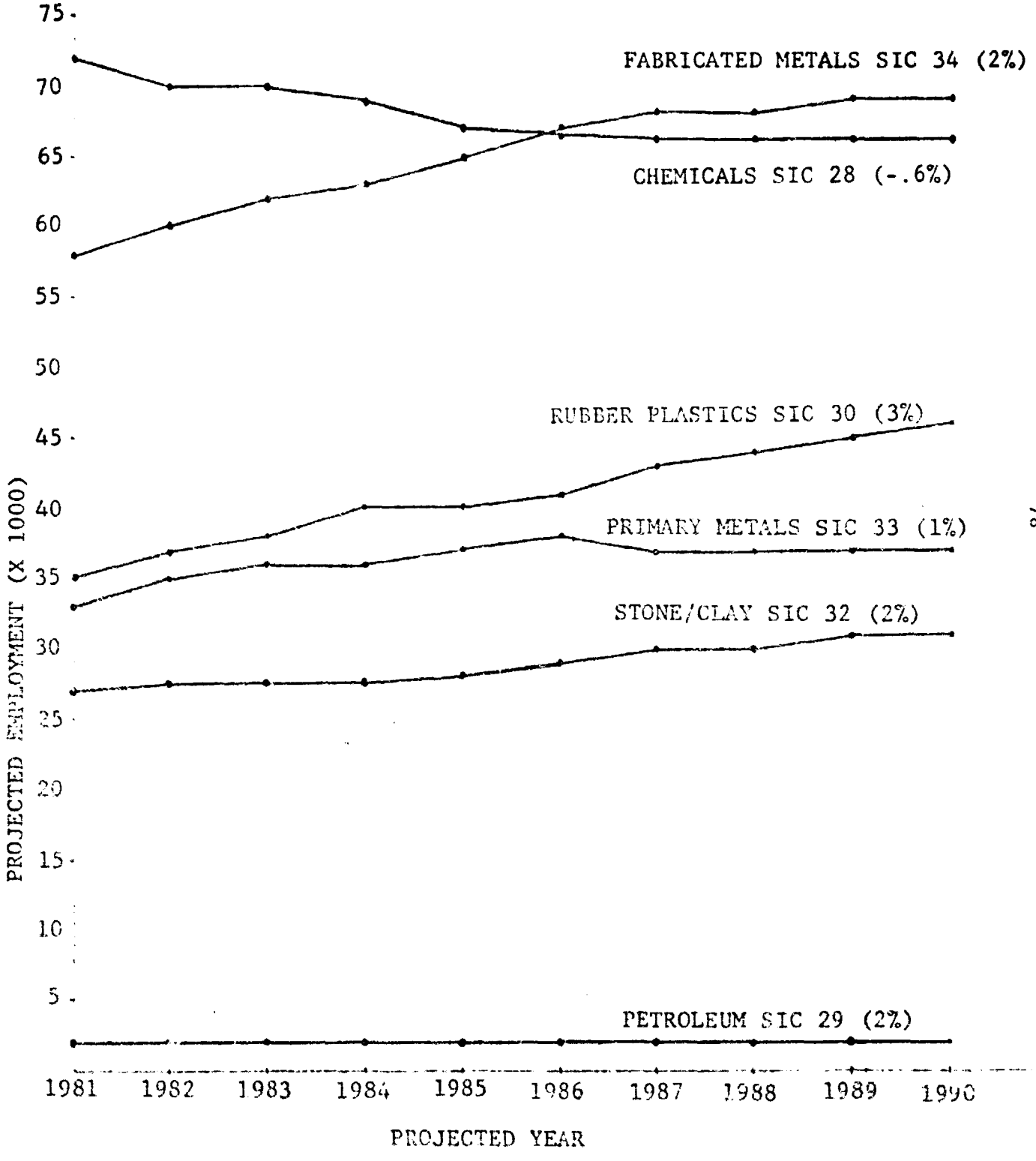
Derived from Gregory Krohm et al., "Candidate Scenarios for the National Coal Utilization Assessment", unpublished report, Argonne National Laboratory, Chicago, Sept. 1, 1976.

PROJECTED INDUSTRIAL EMPLOYMENT

TDC found that industrial employment and energy useage are correlated. Estimated employment in the TVA power service area is expected to increase by small percentages in all industries except chemicals. The figure also indicates which industries are the larger employers in the region of consideration. Rubber, primary metals, and chemicals are expected to be major industries with an initial high propensity to consume synthetic fuels.

PROJECTED INDUSTRIAL EMPLOYMENT

TVA POWER SERVICE AREA
(170 COUNTIES)
TVA REGIONAL ECONOMIC SIMULATION MODEL



ALABAMA ENERGY CONSUMPTION

During the middle 1970's, Alabama natural gas useage declined, while oil and electricity increased. Industrial energy useage declined due to curtailments and conservation.

ALABAMA ENERGY CONSUMPTION

	1972 (%)		1976 (%)
TYPE OF ENERGY			
NATURAL GAS	26	-	21 - 5%
OIL	37	-	48 +11%
ELECTRICITY	13	-	14 + 1%
COAL	24	-	17 - 7%
END-USERS			
INDUSTRIAL	42		37 - 5%
TRANSPORTATION	30		36 + 6%
AGRICULTURAL	.1		.1 0%
COMMERCIAL	15		13 - 2%
RESIDENTIAL	13		14 + 1%

REGIONAL ENERGY GROWTH

Between 1975 and 1976, energy growth fluctuated among the cities in the region under consideration. Huntsville, Nashville, and Florence experienced large industrial energy growth. Gadsden and Memphis declined in growth. The total group change amounted to a 7.4% increase.

REGIONAL ENERGY GROWTH

	1976 ENERGY CONSUMPTION*	1975 ENERGY CONSUMPTION*	Δ CHANGE	% CHANGE
1. HUNTSVILLE	8	6	+2	+33
2. GADSDEN	11	11.4	-0.4	- 4
3. NASHVILLE	30	25	+5	+20
4. FLORENCE	33	28	+5	+18
5. CHATTANOOGA	41	40	+1	+ 2
6. MEMPHIS	45	46	-1	- 2
	168	156	12	

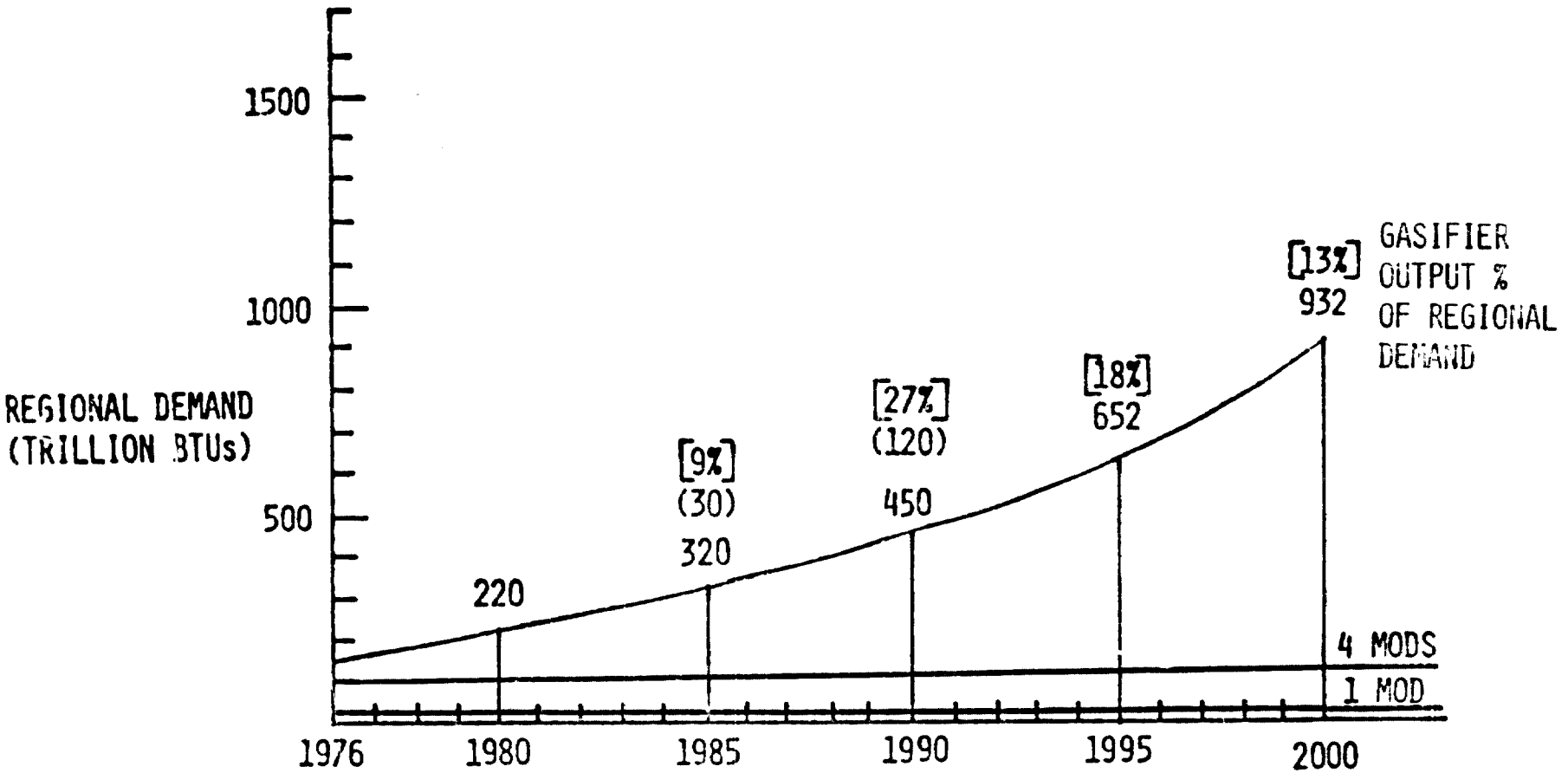
TOTAL GROUP CHANGE FROM 1975 TO 1976 $= \frac{12}{156} = 7.4\%$

*TOTAL INDUSTRIAL PURCHASE ENERGY (TRILLIONS BTU/YR)

PROJECTED REGIONAL DEMAND

Assuming an average of 7.4% regional growth is correct, 1976 regional industrial useage of 169 trillion BTU/YR (Bureau of Census) escalates significantly at a compounded rate. The total gasification facility outputs approximately 100 trillion BTU/YR (depending on process selection), therefore the facility would currently saturate the regional market. However, if compounded growth is accounted for, the facility would not saturate the market. The first module (30 trillion BTU/YR) is expected to be on-line in 1985, subsequent modules (up to 120 trillion BTU/YR) will be on-line by 1990.

PROJECTED REGIONAL DEMAND
[7.4%]



NORTHERN ALABAMA INDUSTRIAL GROWTH

During 1978, significant industrial growth occurred in paper, rubber, fabricated metals, and transportation equipment in Northern Alabama. There were 19 new plants and 80 expanded plants during the year. Over 3,000 new employees were added to the area.

INDUSTRIAL DEVELOPMENT DURING CALENDAR YEAR 1978

ALABAMA TVA DISTRICT

NEW PLANTS	15
EXPANSION PLANTS	[illegible]
TOTAL	20

9[illegible] FIRMS REPORTED INVESTMENT OF	$131,962,000
9[illegible] FIRMS REPORTED EMPLOYMENT OF	2,027
[illegible] FIRMS REPORTED PAYROLL OF	36,[illegible]05

SUMMARY BY MAJOR INDUSTRY GROUPS *

SIC		SQ. FEET	INVESTMENT	EMPLOYMENT
10	- MINING AND QUARRYING		$1,770,000	15
20	- FOOD AND KINDRED PRODUCTS	2,[illegible]29	9,710,000	260
21	- TOBACCO MANUFACTURES	[illegible]	170,000	5
22	- TEXTILE MILL PRODUCTS		2,765,000	105
23	- APPAREL AND FINISHED FABRIC PRODUCTS	2,[illegible]00	4,185,000	315
24	- LUMBER AND WOOD PRODUCTS	42[illegible]	1,[illegible]35,000	180
25	- FURNITURE AND FIXTURES	7[illegible]	[illegible],000	75
26	- PAPER AND ALLIED PRODUCTS	6[illegible]	[illegible],560,000	315
27	- PRINTING, PUBLISHING, AND ALLIED PRODUCTS	5,[illegible]00	645,000	40
28	- CHEMICALS AND ALLIED PRODUCTS	13[illegible]		
30	- RUBBER AND MISCELLANEOUS PLASTIC PRODUCTS	310	2,625,000	
31	- LEATHER AND LEATHER PRODUCTS	6,190	60,[illegible]15,000	45
32	- STONE, CLAY, AND GLASS PRODUCTS	50		475
33	- PRIMARY METALS		50,000	
34	- FABRICATED METAL PRODUCTS	760	500,000	20
35	- MACHINERY, EXCEPT ELECTRICAL	5,[illegible]75	5,300,000	5
36	- ELECTRICAL AND ELECTRONIC MACHINERY	930	17,310,[illegible]00	20
37	- TRANSPORTATION EQUIPMENT	200	7,520,000	555
38	- MEASURING, ANALYZING, AND CONTROLLING INSTRUMENTS	1,[illegible]00	11,850,000	57
			2,900,000	310
			150,000	245
				5
	TOTALS	39,[illegible]54	$160,837,000	3,057
	COMPARABLE TOTALS - PREVIOUS YEAR	76,620	$418,829,000	6,044

* INCLUDES BOTH REPORTED AND STATISTICALLY ESTIMATED DATA.

CENTRAL TENNESSEE INDUSTRIAL GROWTH

Rubber, primary metals, and transportation equipment experienced significant growth in Central Tennessee during 1978. 34 new plants were built and 62 plants were expanded.

INDUSTRIAL DEVELOPMENT DURING CALENDAR YEAR 1978

CENTRAL TENNESSEE DISTRICT

NEW PLANTS	34	79 FIRMS REPORTED INVESTMENT OF	$155,520,000
EXPANDED PLANTS	52	78 FIRMS REPORTED EMPLOYMENT OF	5,235
TOTAL	86	57 FIRMS REPORTED KW DEMAND OF	47,495

SUMMARY BY MAJOR INDUSTRY GROUPS *

SIC	KW DEMAND	INVESTMENT	EMPLOYMENT
20 - FOOD AND KINDRED PRODUCTS	1,110	$2,600,000	120
21 - TOBACCO MANUFACTURERS	1,300	26,000,000	135
22 - TEXTILE MILL PRODUCTS	100	140,000	15
23 - APPAREL AND FINISHED FABRIC PRODUCTS	450	580,000	170
24 - LUMBER AND WOOD PRODUCTS	300	610,000	5
25 - FURNITURE AND FIXTURES	700	1,280,000	110
26 - PAPER AND ALLIED PRODUCTS	1,800	15,825,000	120
27 - PRINTING, PUBLISHING, AND ALLIED PRODUCTS	2,040	13,100,000	95
28 - CHEMICALS AND ALLIED PRODUCTS	3,650	3,360,000	570
30 - RUBBER AND MISCELLANEOUS PLASTIC PRODUCTS	13,800	40,250,000	1,620
31 - LEATHER AND LEATHER PRODUCTS	800	2,700,000	200
32 - STONE, CLAY, AND GLASS PRODUCTS	4,100	14,650,000	640
33 - PRIMARY METALS	14,450	9,350,000	155
34 - FABRICATED METAL PRODUCTS	2,000	3,155,000	205
35 - MACHINERY, EXCEPT ELECTRICAL	1,085	2,760,000	205
36 - ELECTRICAL AND ELECTRONIC MACHINERY	1,335	3,550,000	525
37 - TRANSPORTATION EQUIPMENT	3,800	17,360,000	345
38 - MEASURING, ANALYZING, AND CONTROLLING INSTRUMENTS	300	500,000	55
39 - MISCELLANEOUS MANUFACTURING INDUSTRIES	475	3,200,000	135
TOTALS	53,595	$160,970,000	5,425
COMPARABLE TOTALS - PREVIOUS YEAR	74,770	$165,800,000	5,570

* INCLUDES BOTH REPORTED AND STATISTICALLY ESTIMATED DATA.

PROJECTED INDUSTRIAL GROWTH IN THE TVA AREA

A summary of current industrial and projected industrial growth is shown for industry types. Lumber and wood products are estimated to grow significantly; also rubber products, machinery, and instrumentation. The chemical industry is currently not expected to grow significantly in the TVA region. However, the Coal Gasification Facility will probably attract several new chemical industries.

PROJECTED INDUSTRIAL GROWTH IN THE TVA AREA*

SIC CODE	MAJOR INDUSTRY GROUPS	NUMBER OF NEW PLANTS	NUMBER OF EXPANS.	AVERAGE** ANNUAL PROJECTED GROWTH (%)
10	METAL MINING	0	0	-
14	MINING & QUARRYING	3	4	-
20	FOOD & KINDRED PRODUCTS	7	18	1.24
21	TOBACCO MANUFACTURERS	0	3	-
22	TEXTILE MILL PRODUCTS	14	19	1.53
23	APPAREL & FINISHED FABRIC PRODUCTS	18	11	0.36
24	LUMBER & WOOD PRODUCTS	14	15	8.34
25	FURNITURE & FIXTURES	7	14	-
26	PAPER & ALLIED PRODUCTS	9	12	2.51
27	PRINTING, PUBLISHING & ALLIED PRODUCTS	1	7	-
28	CHEMICALS & ALLIED PRODUCTS	9	12	0.40
29	PETROLEUM REFINING & RELATED INDUSTRIES	0	1	-
30	RUBBER & MISCELLANEOUS PLASTIC PRODUCTS	12	33	3.72
31	LEATHER & LEATHER PRODUCTS	3	3	-
32	STONE, CLAY & GLASS PRODUCTS	6	7	-
33	PRIMARY METALS	8	18	-
34	FABRICATED METAL PRODUCTS	24	21	-
35	MACHINERY, EXCEPT ELECTRICAL	14	24	3.56
36	ELECTRICAL & ELECTRONIC MACHINERY	6	18	2.69
37	TRANSPORTATION EQUIPMENT	12	9	3.56
38	MEASURING, ANALYZING & CONTROLLING INSTRUMENTS	1	4	4.10
39	MISCELLANEOUS MANUFACTURING INDUSTRIES	3	1	-
	TOTALS	171	254	
	COMPARABLE TOTALS - PREVIOUS YEAR	207	319	

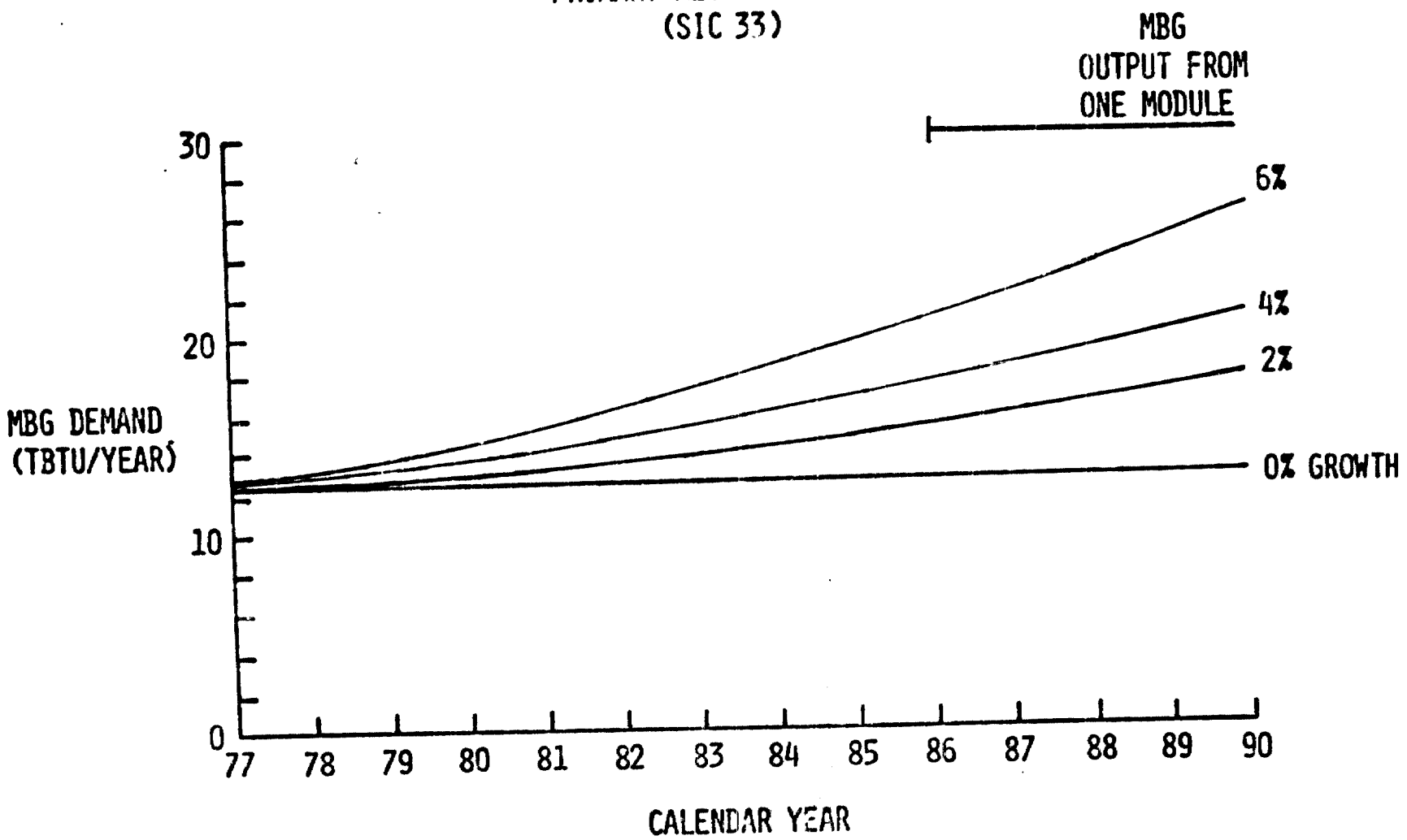
* INCLUDES BOTH REPORTED & STATISTICALLY ESTIMATED DATA (1978 DATA)
** PROJECTED THROUGH YEAR 1986 (TENNESSEE ECONOMETRIC MODEL, CENTER FOR BUSINESS & ECONOMIC RESEARCH, UNIVERSITY OF TENNESSEE)

NORTHERN ALABAMA MBG MARKET PROJECTIONS
PRIMARY METALS

In Northern Alabama during 1977, primary metals consumed 13 trillion BTU/YR's in natural gas and fuel oil. Even if an estimated growth of 6% compounded per year is considered, one module (30 trillion BTU/YR) would saturate the market assuming a 100% conversion of primary metals industry to medium-BTU gas.

NORTHERN ALABAMA MBG MARKET PROJECTIONS

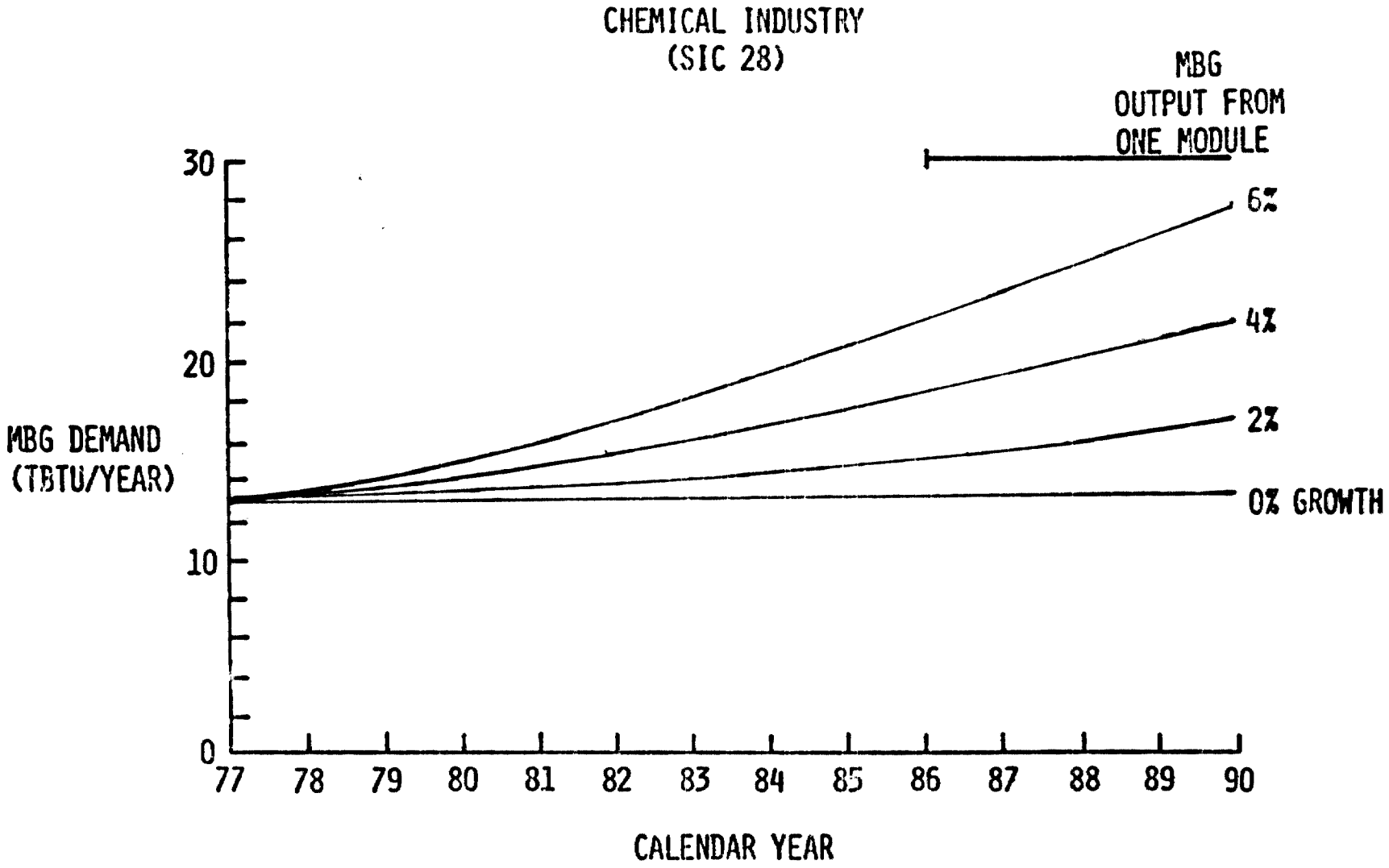
PRIMARY METALS INDUSTRY
(SIC 33)



NORTHERN ALABAMA MBG MARKET PROJECTIONS
CHEMICAL INDUSTRY

Chemical industries in Northern Alabama could not consume all the medium-BTU gas from one facility module even at an optimistic growth rate.

NORTHERN ALABAMA MBG MARKET PROJECTIONS

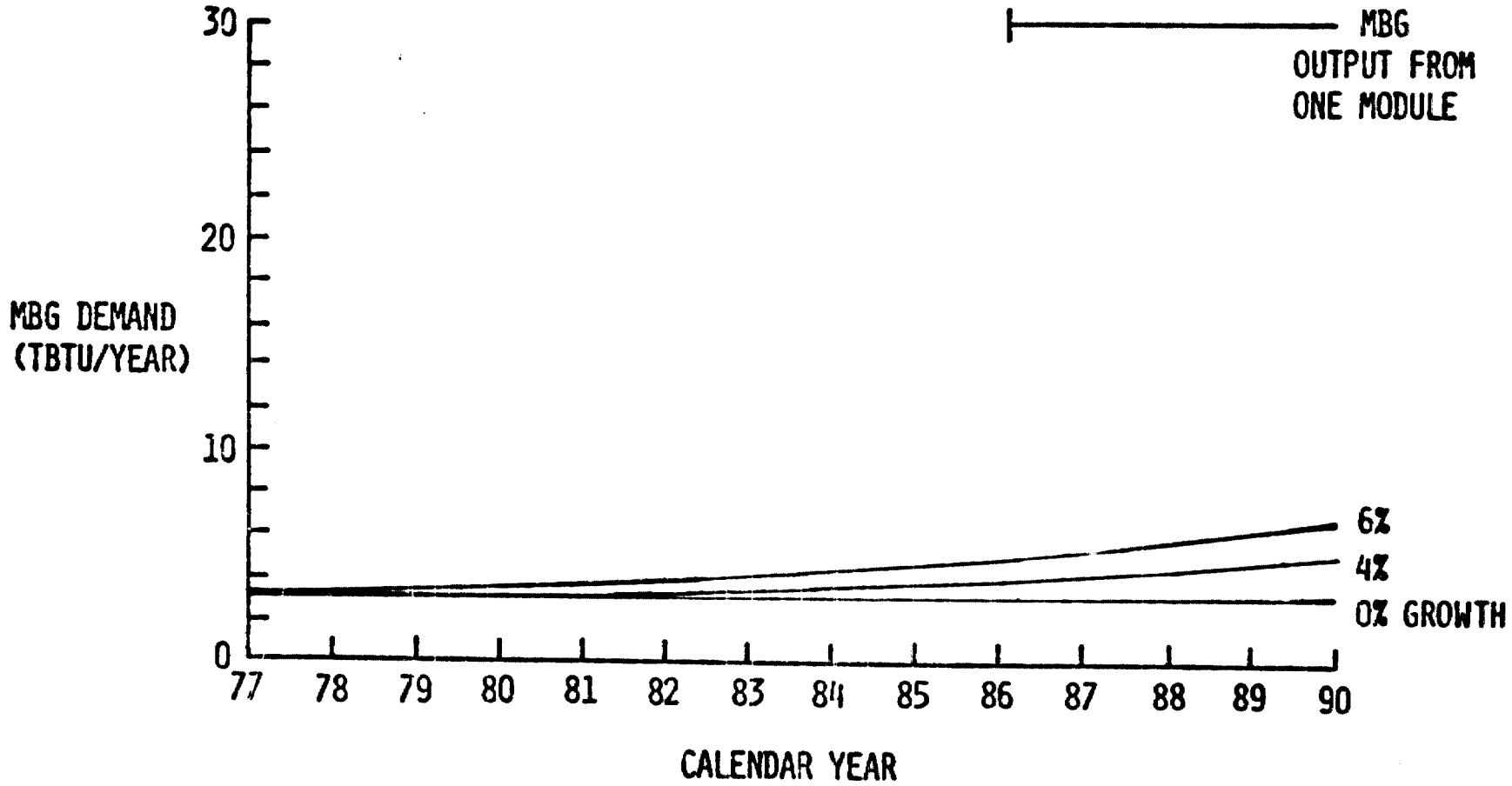


NORTHERN ALABAMA MBG MARKET PROJECTIONS
RUBBER INDUSTRY

Currently, the Northern Alabama rubber industry consumes about 3.5 trillion BTU/YR in natural gas and fuel oil. The amount of rubber industry consumption is significantly less than one module output of MBG.

NORTHERN ALABAMA MBG MARKET PROJECTIONS

RUBBER INDUSTRY
(SIC 30)

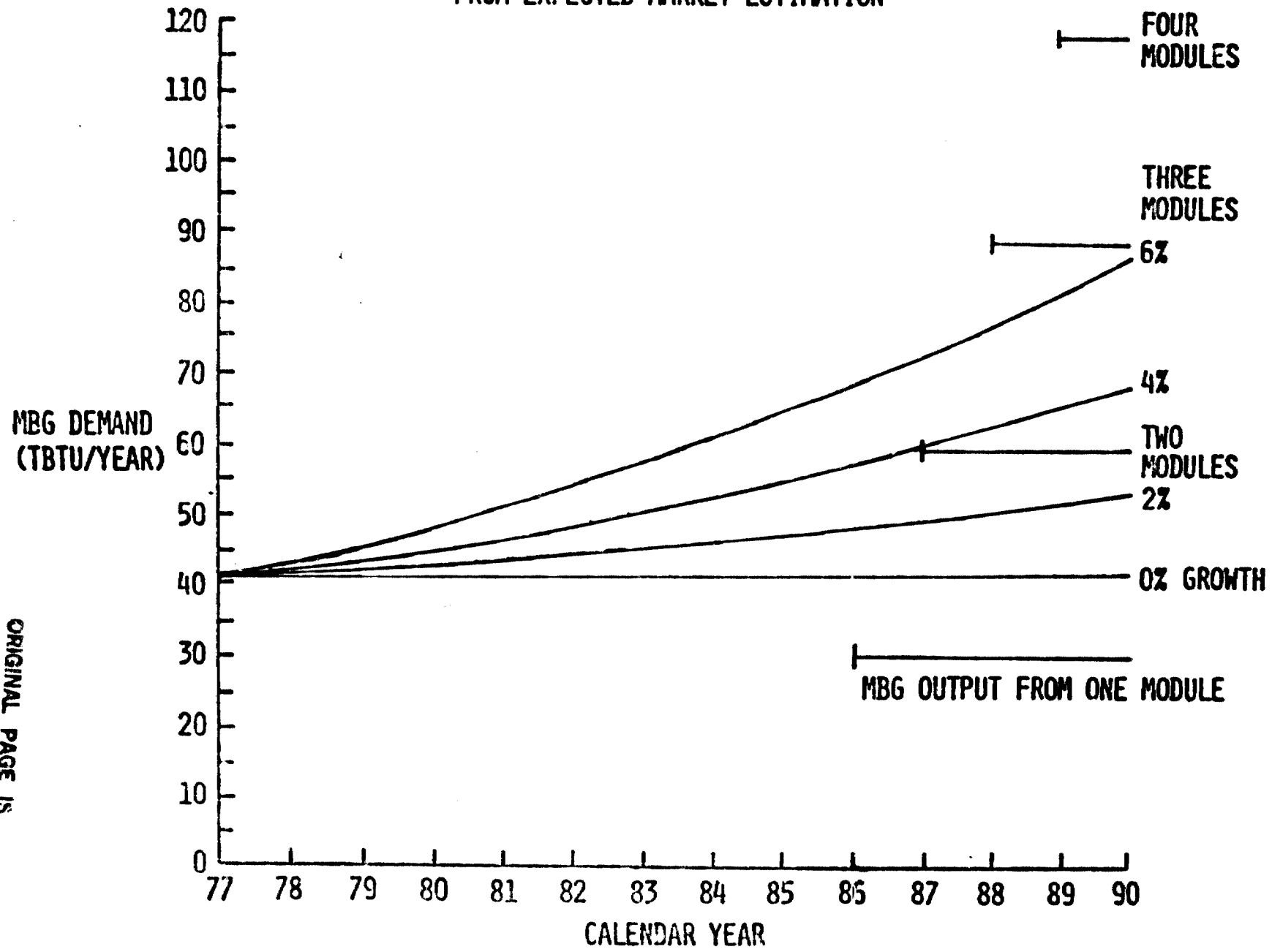


NORTHERN ALABAMA MBG MARKET PROJECTIONS
EXPECTED MARKET ESTIMATION

The expected market for MBG in Northern Alabama is estimated to be about 40 TBTU/YR in 1977. At an average of 4% energy growth per year, outputs of two modules (assuming 100% industry conversion) could equal the market demand by 1987.

NORTHERN ALABAMA MBG MARKET PROJECTIONS

FROM EXPECTED MARKET ESTIMATION

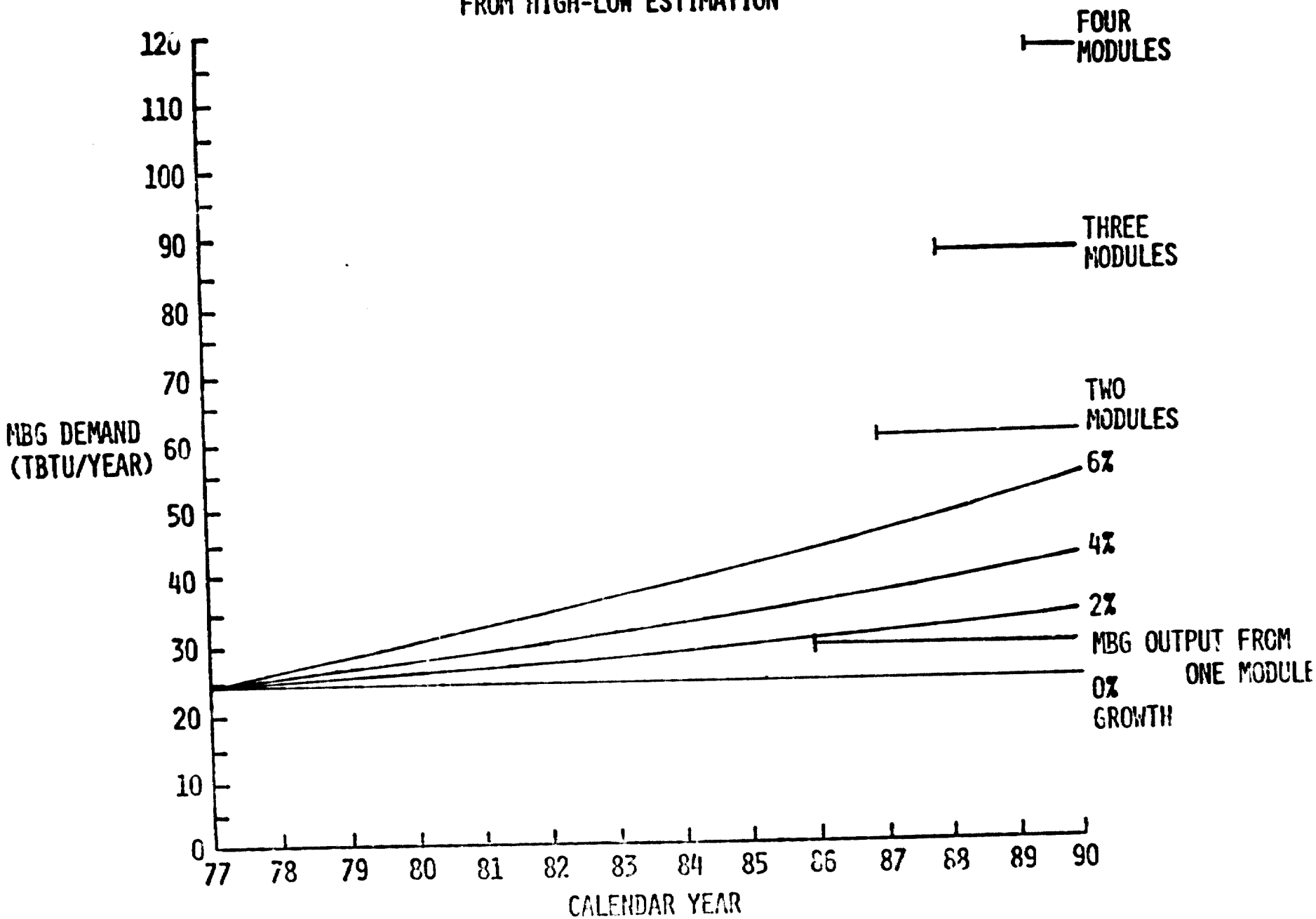


ORIGINAL PAGE IS OF POOR QUALITY

NORTHERN ALABAMA MBG MARKET PROJECTIONS FROM HIGH-LOW ESTIMATION

The high-low estimation technique is a conservative method including only primary metals, chemicals, and rubber industries located within 10 miles of the conceptual NASA pipeline configuration. For Northern Alabama, about 25 TBTU/YR of medium-BTU gas is the 1977 market potential. Two modules' output would saturate the market for MBG.

NORTHERN ALABAMA MBG MARKET PROJECTIONS
FROM HIGH-LOW ESTIMATION

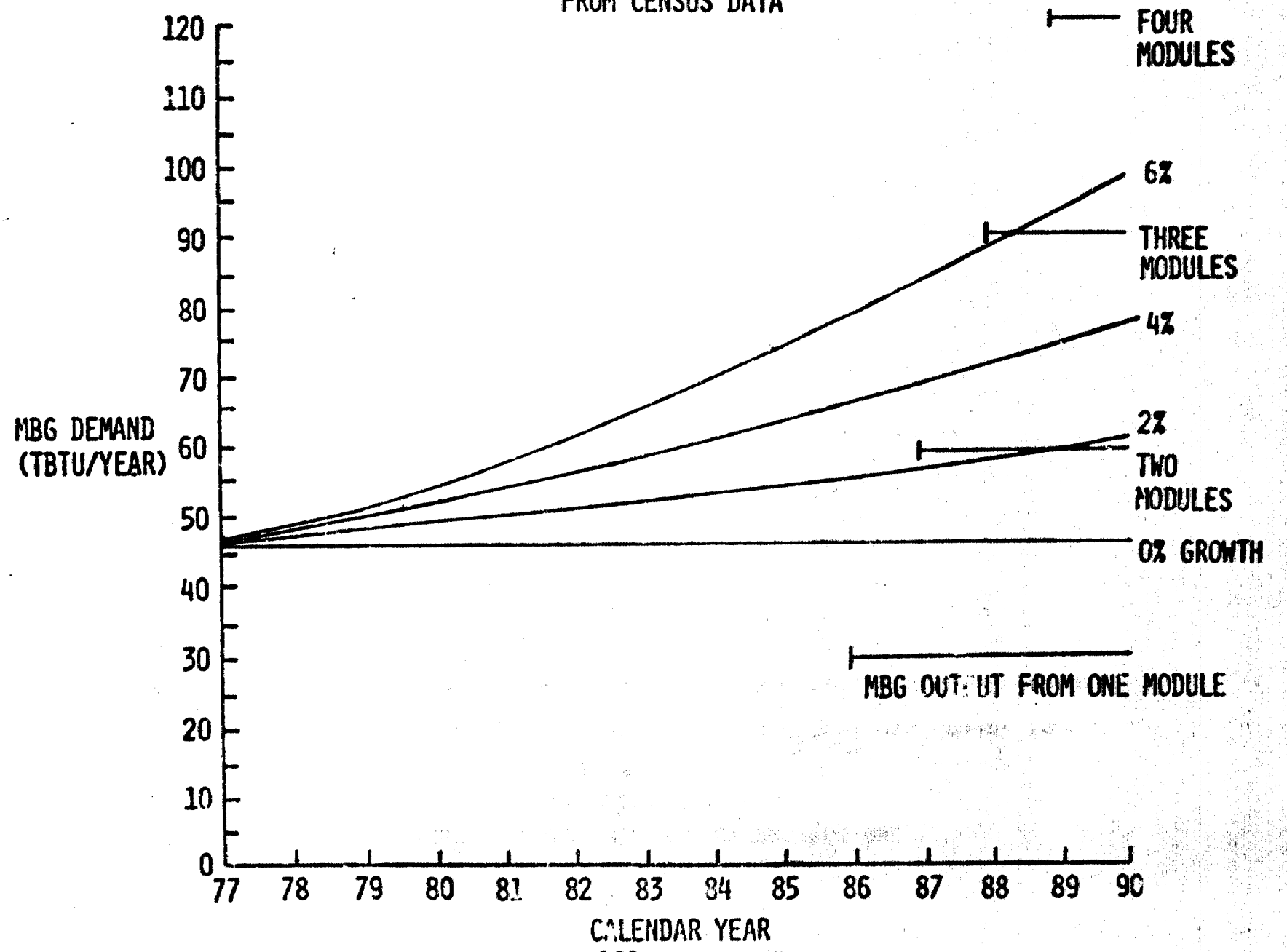


NORTHERN ALABAMA MBG MARKET PROJECTIONS
CENSUS DATA

The Bureau of Census industrial energy consumption data for Northern Alabama is about 47 TBTU/YR in 1977. If all industries converted to MBG, and industrial energy growth exceeds 2 percent per year, two modules could serve Northern Alabama.

NORTHERN ALABAMA MBG MARKET PROJECTIONS

FROM CENSUS DATA



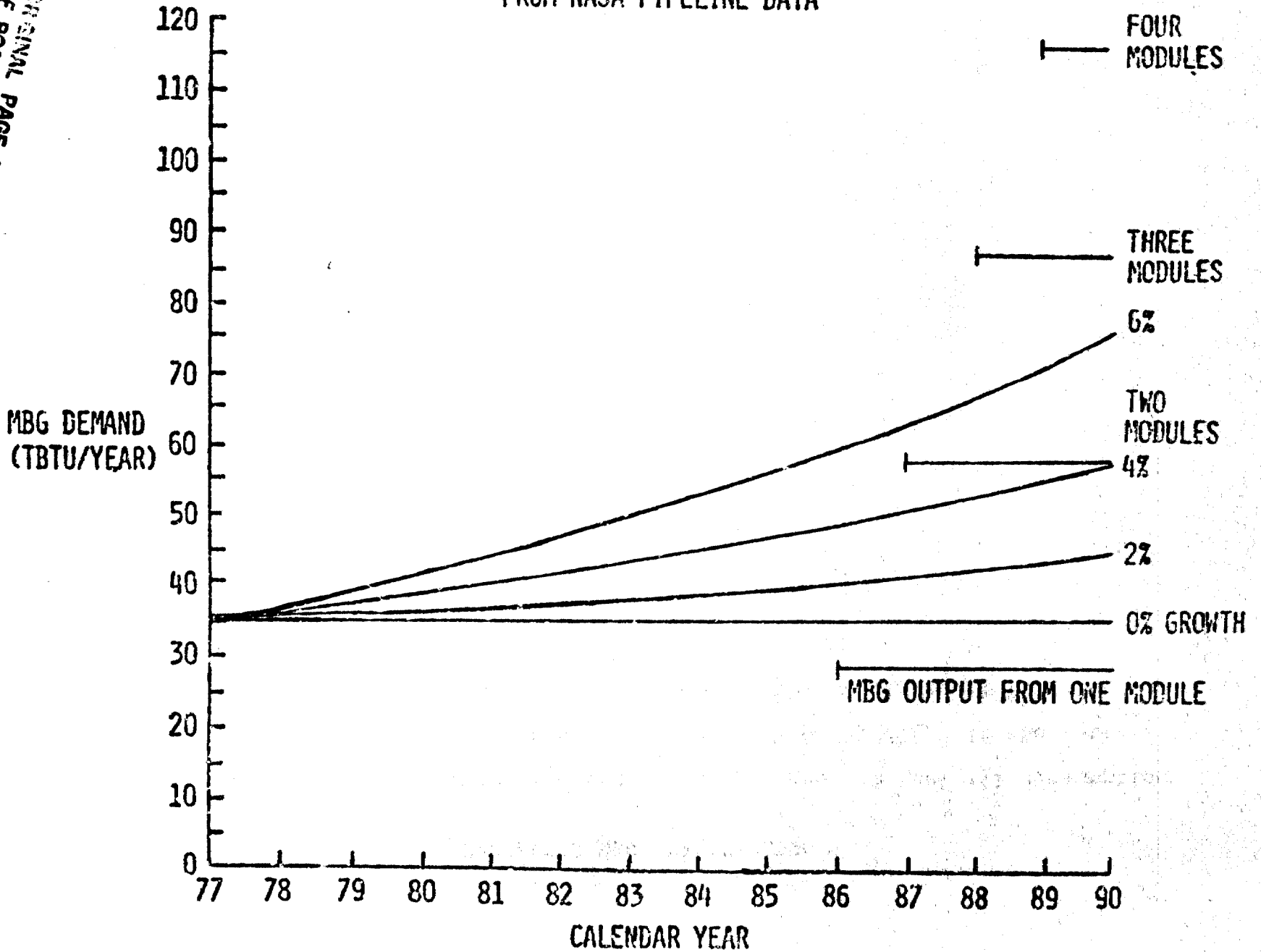
NORTHERN ALABAMA MBG MARKET PROJECTIONS
NASA PIPELINE DATA

TVA provided to NASA estimated natural gas and fuel oil demand in Northern Alabama (35 TBTU/YR). Two modules of MBG output could only be used if energy useage growth rates exceed 4% per year.

ORIGINAL PAGE IS OF POOR QUALITY

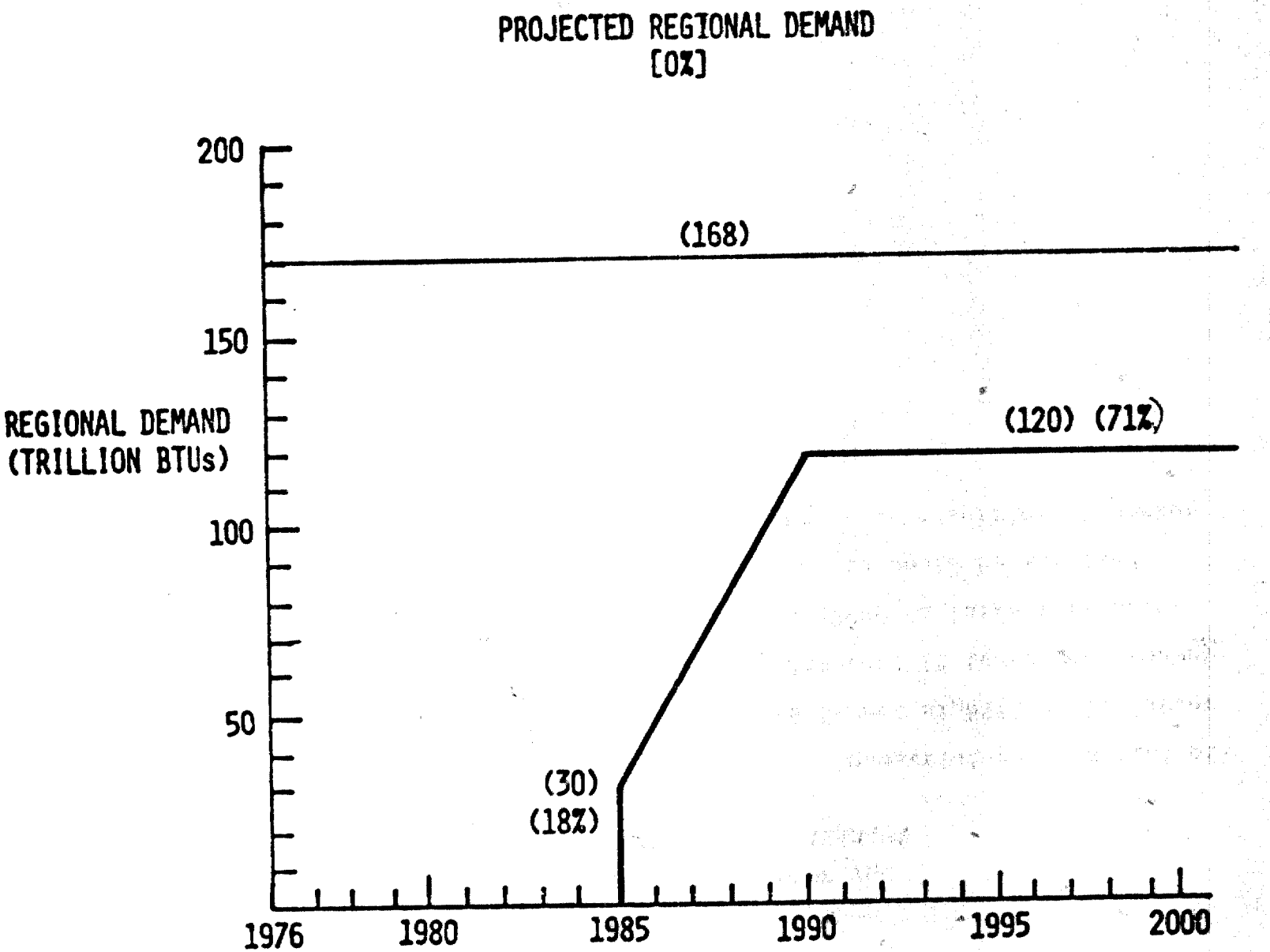
NORTHERN ALABAMA MBG MARKET PROJECTIONS

FROM NASA PIPELINE DATA



PROJECTED REGIONAL DEMAND

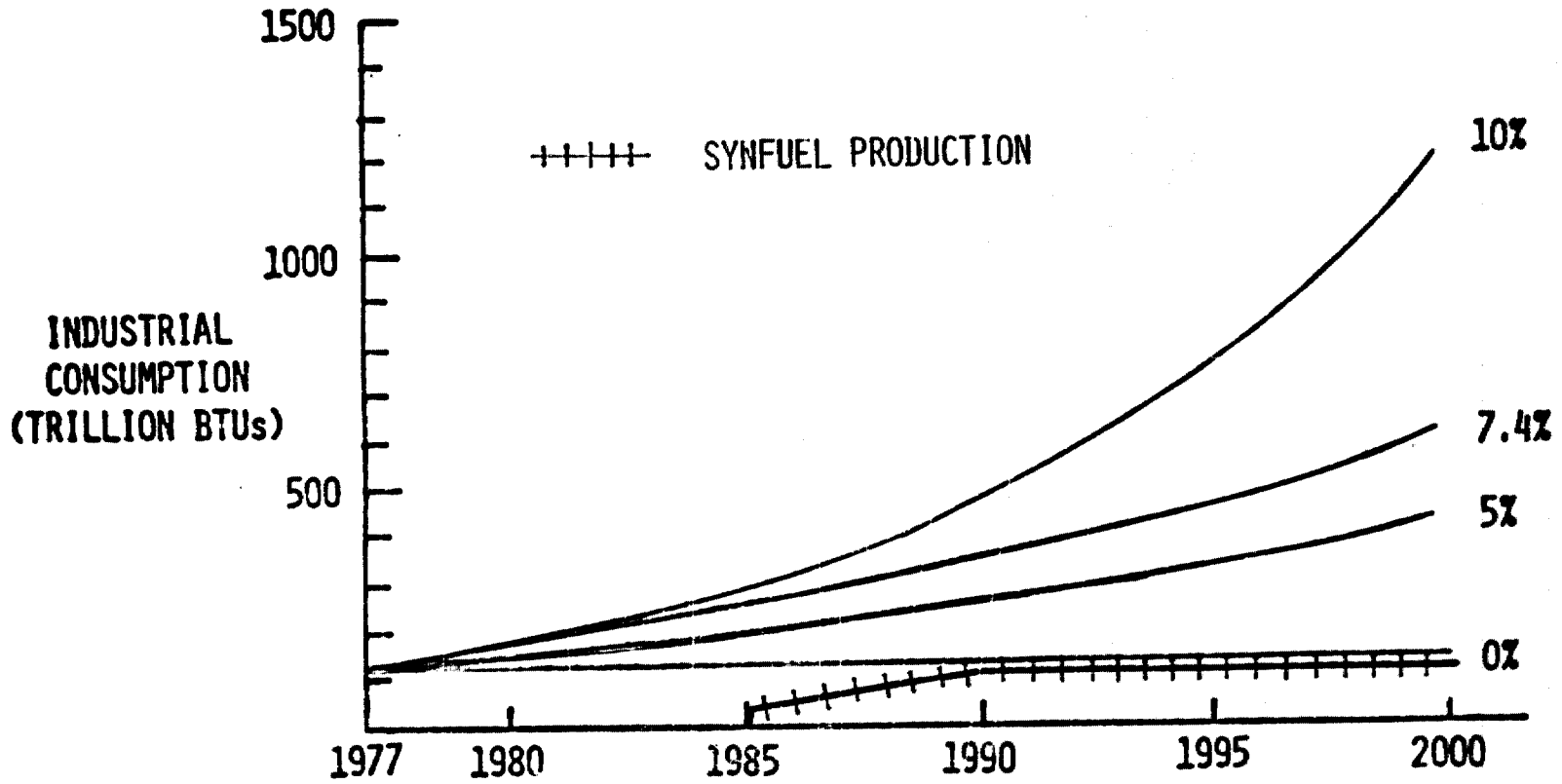
The total Bureau of Census industrial natural gas and fuel oil consumption in Northern Alabama and South Central Tennessee is 168 TBTU/YR. If the Coal Gasification Facility outputs 120 TBTU/YR by 1990, this would equal 71% of the total market.


PROJECTED REGIONAL DEMAND
[0%]
200
150
100
50
REGIONAL DEMAND
(TRILLION BTUs)
(168)
(120) (71%)
(30)
(18%)
1976
1980
1985
1990
1995
2000

NATURAL GAS AND FUEL OIL CONSUMPTION WITHIN 100 MILES OF COURTLAND, ALABAMA

As was previously pointed out, the current total industrial gas and fuel oil comsumption in Northern Alabama and Central Tennessee is not significantly larger than the output of the Coal Gasification Facility. However, if industrial energy growth is factored in and compounded yearly until 1990-2000, a large margin for market penetration exists. Assuming the synfuels products would be marketed within 100 miles of the proposed site at Courtland, there is a sufficient market for penetration.

COMBINED NATURAL GAS/FUEL OIL
INDUSTRIAL CONSUMPTION WITHIN
100 MILES OF COURTLAND, AL.



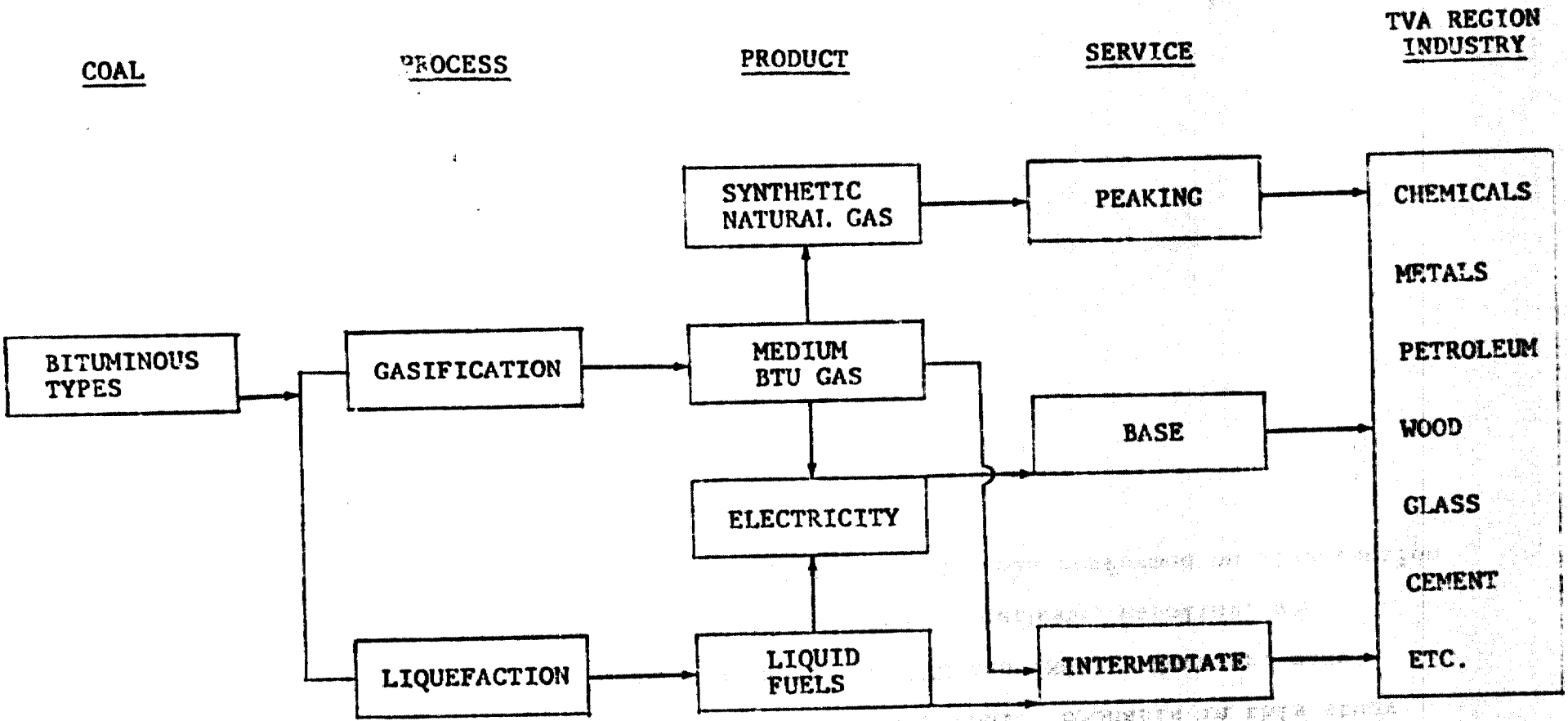
SECTION 4. CURRENT AND PROJECTED SYNTHETIC FUELS APPLICATIONS

SIMPLIFIED COAL TO INDUSTRIAL APPLICATION

For the industry types identified in the previous sections, potential demands for coal-based synthetic fuels are determined in this section. Synfuels can be derived from coal by gasification or liquefaction. Typical products are medium-BTU gas, fuel cell electricity, synthetic natural gas, and liquid fuels such as gasoline. These alternate products can be produced during peaking, base, or intermediate load demand periods. Various industries can utilize synthetic fuels; primary metals, chemicals, and rubber industries are prime candidates.

ORIGINAL PAGE IS
OF POOR QUALITY

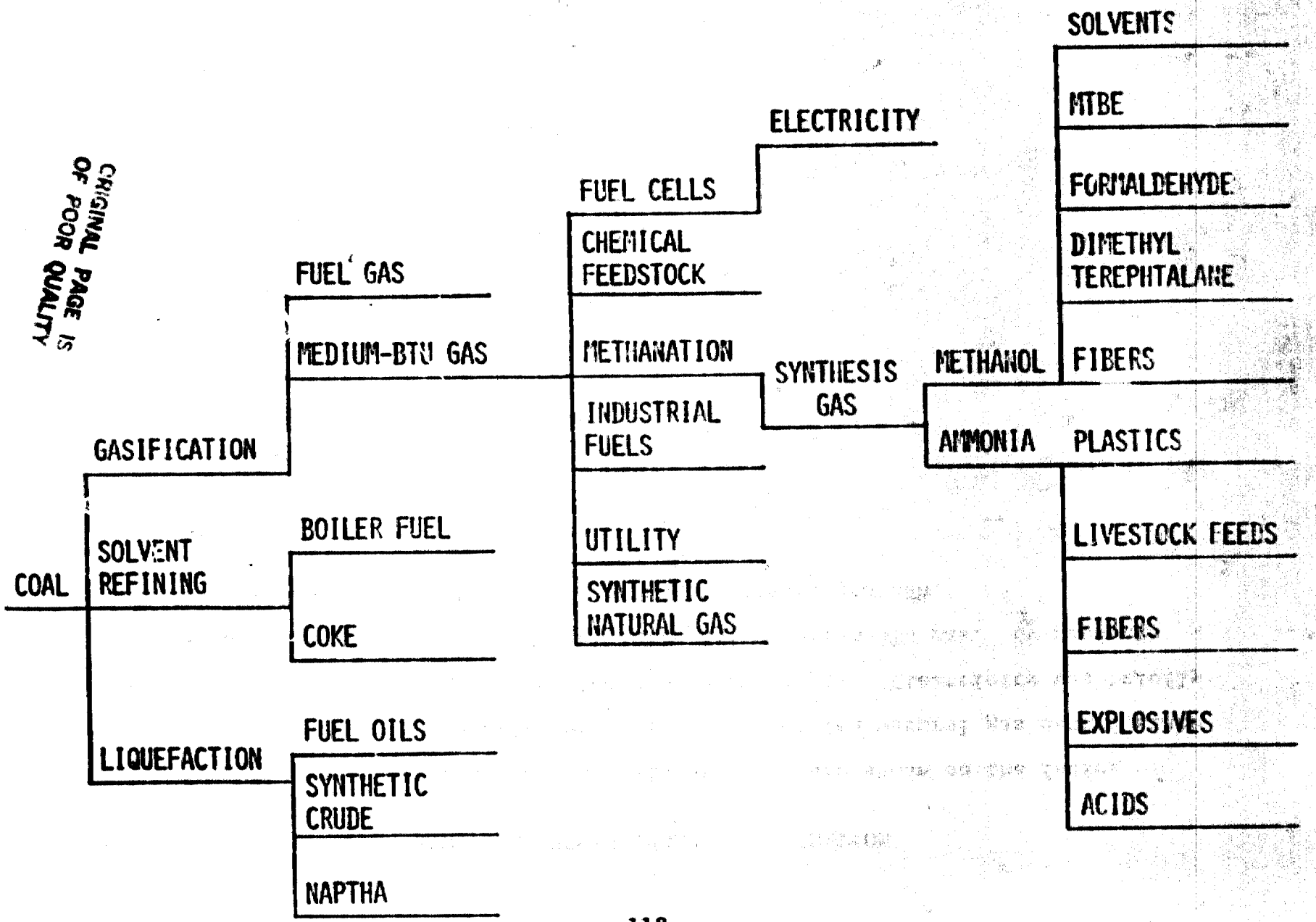
SIMPLIFIED COAL TO INDUSTRIAL APPLICATION



POSSIBLE COAL UTILIZATION PRODUCTS

Many different products can be derived from coal. Emphasis in this study has been on production and marketing of medium-BTU gas (MBG). However, many synfuels can be derived from MBG, such as methanol, methane, gasoline, and fuel cell electricity. A brief feasibility analysis was performed on liquefaction of coal to produce fuel oils.

POSSIBLE COAL UTILIZATION PRODUCTS



ORIGINAL PAGE IS OF POOR QUALITY

SYNTHETIC FUELS UNDER CONSIDERATION

Synfuels and their order of analysis priority are shown on the facing page. Fuel oil was combined with natural gas and called natural gas demand since industries use fuel oil when curtailed from natural gas. Electricity was briefly examined as being generated from fuel cells using medium-BTU gas. By-products include possible exports of sulphur, nitrogen, steam, and ash.

SYNTHETIC FUELS UNDER CONSIDERATION

- Medium-BTU Gas
- Electricity
- Gasoline
- Fuel Oil
- Methane
- Methanol
- By-Products

INDUSTRIAL SYNTHETIC FUELS USEAGE CRITERIA

To do a detailed synfuel industrial applications analysis, the useage criteria illustrated on the facing page should be accomplished. In this report, each topic was only superficially addressed during the three-month study.

INDUSTRIAL SYNTHETIC FUELS USEAGE CRITERIA

- INDUSTRIAL FUEL ENERGY CONTENT, CHEMICAL COMPOSITION, AND CHARACTERISTICS
- INDUSTRIAL CAPACITY AND ENERGY CURTAILMENT
- FUEL COST AND PRICE
- RETROFIT REQUIREMENTS ESTIMATES
- INDUSTRY LOCATION WITH RESPECT TO FUEL TRANSPORTATION MODES
- INDUSTRY ENERGY INNOVATION

STUDY CAVEATS

In examining the data presented in this report, the reader should always keep in mind the three caveats shown on this chart. The number of BTU's produced by the Coal Gasification Facility can range in value from 20 to 30 trillion BTU's per module per year, and from 80 to 120 trillion BTU's per year for a complete four-module facility. In the charts shown in this study, the upper limits of 30 trillion BTU's for one module or 120 trillion BTU's for a complete plant are used.

Bureau of Census data is compiled for Standard Metropolitan Statistical Areas (SMSA).

STUDY CAVEATS

- GASIFICATION BTU'S ARE THEORETICAL MAXIMUM
- ENERGY ESTIMATES ARE FOR MANUFACTURING INDUSTRIES ONLY
  - NO UTILITIES
  - NO HOUSEHOLDS
- "AREAS" REFER TO "STANDARD METROPOLITAN STATISTICAL AREAS"
  - MULTI-COUNTY

THEORETICAL COAL GASIFICATION BTU'S

This chart goes through a theoretical calculation of the BTU's produced by a gasification plant. It is obvious that such a factor as the number of days of operation, the type of coal, the BTU content of the product, etc., will affect the total number of BTU's which are actually produced.

THEORETICAL COAL GASIFICATION BTU'S

(1) 12,800 TONS/DAY OF MAF COAL

(2) (12,800) (2,000 LBS/DAY/TONS) = 256×10^5 LBS/DAY

(3) FOR 355 DAYS/YEAR OF OPERATION

(4) (256×10^5) (355) = $9{,}088 \times 10^9$ LBS/YEAR

(5) ASSUME 56 SLF OF GAS/LB

(6) ASSUME 241 BTU/SCF

(7) BTU/LB OF MAF COAL = 13,496

(8) BTU/YEAR = (13496) (9.088×10^9)

= 122×10^{12} BTU/YEAR

= 122 TRILLION BTU/YEAR FOR 4 GASIFIERS

= 30 TRILLION BTU/YEAR FOR 1 GASIFIER

COAL-BASED SYNTHETIC FUELS COMPLEX PRODUCTS

Possible synthetic fuels from different modules, energy outputs, and year are illustrated. Therefore, the facility could output medium-BTU gas, electricity, synthesis gas, fuel oil, and naptha. The combinations of products are not optimized in this study. A detailed systems, cost, price, and market study could define optimum product mixes. A brief report entitled "Synfuels Facility Products and Revenues" by TDC briefly addressed product options.

COAL BASED SYNTHETIC FUELS COMPLEX PRODUCTS
(5,000 TPD EACH MODULE)

MODULE #1: 1986 - 28×10^{12} BTU/YR MEDIUM-BTU GAS

MODULE #2: 1987 - 28×10^{12} BTU/YR MEDIUM BTU/GAS
+ FUEL CELLS ⟶ 23.2×10^{12} BTU/YR ELECTRICITY

MODULE #3: 1988 - 28×10^{12} BTU/YR MEDIUM-BTU GAS +
METHANATION + SYNTHESIS GAS ⟶ 23.2×10^{12} BTU/YR
METHANOL*

MODULE #4: 1989 - SRC-II 2.60×10^{12} BTU/YR #2 FUEL OIL*
21.5×10^{12} BTU/YR #6 FUEL OIL*
5.28×10^{12} BTU/YR NAPTHA*

* 328 PRODUCTION DAYS PER YEAR

NOTE: FUEL CELLS AND METHANOL EFFICIENCY ASSUMED IS 55%

INDUSTRIAL FUELS FROM COAL CONVERSION

Low, medium, and synthetic natural gas (SNG) can be produced from coal. The heating value, flame temperature, flue gas volume, and SO_2 emission are shown for the three gases. The flame temperature of medium-BTU gas and natural gas are the same. SO_2 emissions are a function of the clean-up system.

INDUSTRIAL FUELS FROM COAL CONVERSION

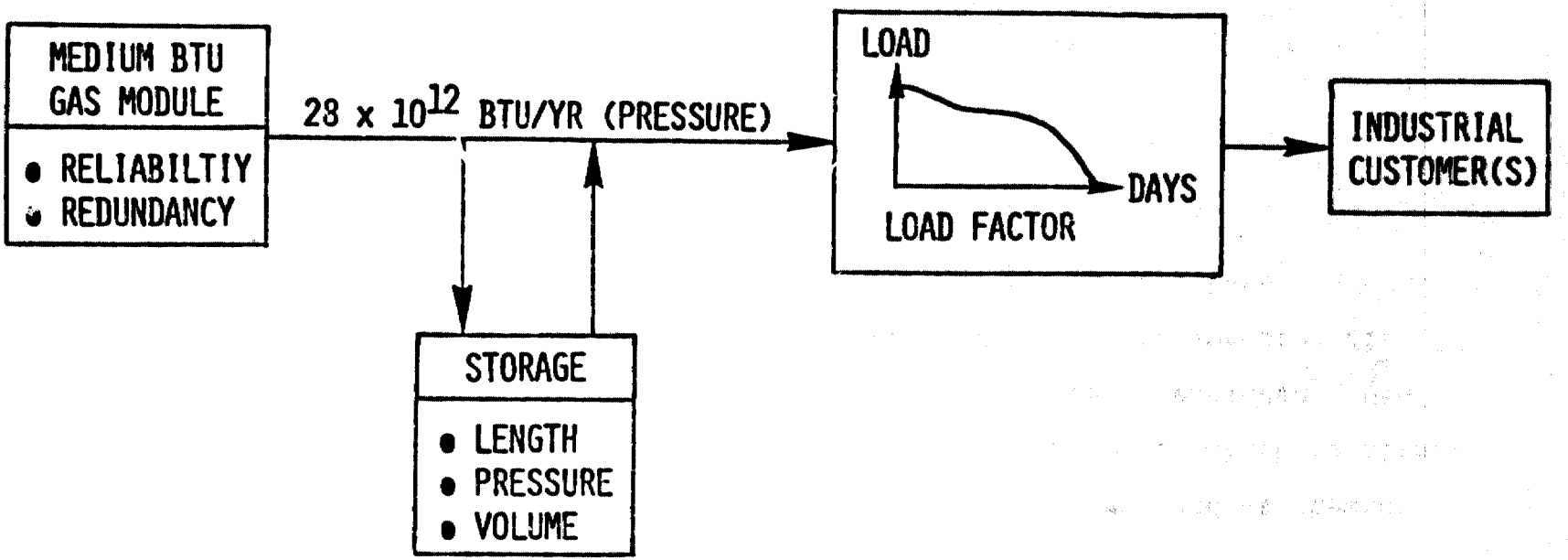
	CLEAN LOW BTU	CLEAN MEDIUM BTU	SNG
LOCATION	ON-SITE	NEAR	MINE-MOUTH PIPELINE
HEATING VALUE (BTU/FT^3)	~ 150	~ 300	1,000
FLAME TEMPERATURE (^oF)	3,000	3,500	3,500
FLUE GAS VOLUME (FT^3/BTU)	13.9	10.7	11.6
SO_2 EMISSION (LB/MIL BTU)	0.3	0.3	.0001

MEDIUM-BTU GAS DELIVERY AND RELIABILITY

One of the major problems in MBG delivery will be maintenance of pressure at the customer considering load variance and pipeline lengths. Storage will be necessary to account for peak demands during winter months when natural gas is curtailed. Also, redundant modules will be necessary to account for equipment failures. MBG may not store well; therefore, the gasifiers may have to be designed to operate near peak load requirements. Excesses of MBG can be converted to alternate products.

MEDIUM BTU GAS

DELIVERY AND RELIABILITY



MBG (UTILITY-TYPE SERVICES)

Major uses of MBG are for space heating, process heating, and as chemical feedstock. MBG does contain large percentages of carbon monoxide which is highly toxic; therefore, residential and commercial useage is probably excluded. MBG production cost should be less inflationary than natural gas and imported oil. Coal is not predicted to escalate in price as natural gas and oil have.

MBG (UTILITY TYPE SERVICE)

- $\sim$ 300 BTU/FT^3 - BULKIER THAN NATURAL GAS FOR SAME AMOUNT OF ENERGY, DIFFICULT TO STORE
- BOILER FUEL FOR EXISTING OIL OR NATURAL GAS FIRED UTILITY BOILERS
- GENERATE STEAM
- FIRING FURNACE KILN AND OVENS FOR PROCESS HEAT
- SPACE HEATING
- REDUCING GAS FOR PROCESS METALLURGY & ORE REDUCTION
- SYNTHESIS GAS FOR CHEMICAL FEEDSTOCK
- CAPITAL INTENSIVE $\therefore$ PRICE SHOULD NOT BE AS INFLATIONARY AS FOREIGN OIL
- IMPACT OF CONTINUAL LARGE PURCHASES OF FOREIGN NATURAL GAS MAY LESSEN MARKET
- GREAT POTENTIAL AS CHEMICAL FEEDSTOCK
- CHEMICAL PLANTS HAVE HIGH LOAD FACTOR REQUIREMENT
- PREDOMINANTLY H_2 & CO $\therefore$ HAZARDOUS FOR RESIDENTIAL
- COSTS 20-30% LESS THAN SNG

EIGHT MAJOR LOAD CENTERS

To obtain more relevant regional data on present energy consumption, TDC examined the size and products of approximately 1,200 industries in Northern Alabama and Tennessee. The industry locations were specified as one of eight major load centers.

DETAILED ANALYSIS OF POTENTIAL MBG USERS
- 8 MAJOR LOAD CENTERS -

1. Chattanooga
2. Central Tennessee
3. Northeast Alabama
4. Northwest Alabama
5. Huntsville
6. Memphis
7. Nashville
8. Birmingham

180 SELECTED PLANTS

From the initial data set of 1,200 specific plants, 180 were selected as more likely to have a propensity to consume medium-BTU gas. The 180 industries are the largest in energy consumption and employee number in Northern Alabama and South Central Tennessee. For these 180 plants, 15 specific data attributes were determined. The weighting factors and MBG consumption potential are defined on the following pages.

DETAILED ANALYSIS OF POTENTIAL MBG USERS
- 180 SELECTED PLANTS -

1. Plant Name
2. Plant Location
3. SIC Code
4. Number of Employees
5. Plant Products
6. Yearly Natural Gas Consumption
7. Yearly Fuel Oil Consumption
8. Distance from Murphy Hill
9. Distance from Courtland
10. MBG Weighting Factor from Murphy Hill Site
11. MBG Weighting Factor from Courtland Site
12. MBG Weighting Factor for Plant Type
13. MBG Weighting Factor for Plant Energy Consumption
14. Potential MBG Consumption for Plant from Murphy Hill Site
15. Potential MBG Consumption for Plant from Courtland Site

MARKET PENETRATION METHODOLOGIES

The 180 selected plants were evaluated, on a per-plant basis, by each of two market penetration methodologies.

The expected consumption technique utilized a mathematical formula to ascribe different weights to plant type, distance from the gasification site, and total natural gas/fuel oil consumption. On the basis of this formula, some fraction of the plant's energy was predicted to be replaceable by medium-BTU gas.

The high-low propensity technique was implemented in the following manner. A canonical pipeline configuration, originating at Murphy Hill, was sent to all major load centers in the region. The distance of each of the 180 plants from this pipeline was determined and then, from an examination of the specific plants, their natural gas and fuel oil consumption was either completely included (high propensity plants) or completely excluded (low propensity plants).

MARKET PENETRATION METHODOLOGIES

- EXPECTED CONSUMPTION TECHNIQUE
  - TYPE OF INDUSTRY
  - DISTANCE FROM GAS SITE
  - QUANTITY OF ENERGY CONSUMED
  - PARTIAL INCLUSION
- HIGH-LOW PROPENSITY TECHNIQUE
  - DISTANCE FROM NASA PIPELINE
  - BINARY INCLUSION

EXPECTED MBG CONSUMPTION

The market penetration technique which has been utilized in this study is called the "Expected MBG Consumption" technique. This technique assumes that the expected MBG consumption, not each specific plant, is equal to the probability of MBG consumption (P_{MBG}), multiplied by the total present natural gas demand (Q_{NG}). Since P_{MBG} is a probability factor, it can range in value from 0 to 1. Therefore, the expected MBG demand for a specific plant is always equal to or less than the present natural gas demand at the plant. It should be noted that "natural gas demand" in the context of this algorithm means the sum of the actual natural gas consumption plus the fuel oil consumption at the plant.

EXPECTED MBG CONSUMPTION

FOR EACH PLANT,

$$Q_{MBG} = \begin{matrix}\text{EXPECTED}\\ \text{MBG}\\ \text{CONSUMPTION}\end{matrix} = \left[\begin{matrix}\text{PROBABILITY}\\ \text{OF}\\ \text{MBG CONSUMPTION}\end{matrix}\right] * \left[\begin{matrix}\text{TOTAL PRESENT}\\ \text{NATURAL GAS}\\ \text{DEMAND}\end{matrix}\right]$$

$$= P_{MBG} * Q_{NG}$$

$$0 \leq P_{MBG} \leq 1$$

PROBABILITY OF MBG CONSUMPTION

The probability factor P_{MBG} includes weighting factors for the type of plant, the distance of the plant from the coal gasification site, and the amount of natural gas and fuel oil consumed at the plant.

The type of plant is important because certain plants, such as basic metals, chemicals, and oil refineries, already utilize low- or medium-BTU gas in their plant operations. These plants would be more likely to accept MBG produced from coal.

The distance factor is important since studies indicate that it is unlikely that MBG would be pumped more than 300 miles; 100 miles or less is probable due to pumping station requirements.

The amount of energy conserved at the plant is important since, obviously, large energy consumers are intensely concerned about interruptions and costs.

PROBABILITY OF MBG CONSUMPTION

For Equivalent Natural Gas and MBG Prices,

$$P_{MBG} = C_1 * TF + C_2 * DF + C_3 * CF$$

$$= (.1)\ TF + (.3)\ DF + (.6)\ CF$$

Where TF = Type of Plant Factor

= 1.0 for Oil Refineries, Steel Mills, Chemical Plants

= 0.5 for All Others

DF = Distance Factor

= $1 - D/300$, D = Distance from MBG Plant

CF = Consumption Factor

= $E_{NG}/1000$, E_{NG} = Natural Gas Demand in Billions of BTU/YR

, If $E_{NG} \leq 1000$ Billion BTU/YR

= 1.0, if $E_{NG} > 1000$ Billion BTU/YR

RATIONALE FOR MBG WEIGHTING FACTORS

This chart indicates the type of rationale which led TRC to develop and utilize a weighted algorithm to determine the fraction of the natural gas market which could be penetrated by the MBG market.

RATIONALE FOR MBG WEIGHTING FACTORS

- Some Industries Already Utilize Low- or Medium-BTU Gas
  - Oil Refineries (Refinery Gas - Low-BTU)
  - Steel Mills (Blast Furnace Gas - Low-BTU)
  - Chemical Plants (Synthesis Gas - Medium-BTU)
- Very Large Natural Gas Users Have More Severe Interruptability and Cost Problems
- Medium-BTU Gas Has Limited Transportability in Distance Due to Economics

EXPECTED NORTH ALABAMA/TENNESSEE MBG MARKET

This chart shows the total present regional demand, by load center, for the 180 plants which were examined. The totals were obtained by summing the computed medium-BTU gas consumption for each individual plant. Since the expected value market penetration algorithm includes distance-from-site as a factor, two site locations were specified for comparison; namely, Courtland, Alabama, and Murphy Hill, Alabama. Load centers are approximately equi-distant from the two sites.

The values in this table should be compared with a projected coal gasification output of 85 to 120 trillion BTU's per year (for four modules).

EXPECTED NORTH ALABAMA/TENNESSEE MBG MARKET

LOAD CENTER	LARGE INDUSTRIAL USER MARKET (TRILLION BTU/YR)	
	MURPHY HILL	COURTLAND
• CHATTANOOGA	17.0	16.0
• CENTRAL TENNESSEE	6.0	6.0
• NORTHEAST ALABAMA	15.0	14.0
• NORTHWEST ALABAMA	25.0	26.0
• HUNTSVILLE	1.0	1.0
• MEMPHIS*	8.0	9.0
• NASHVILLE	6.0	6.0
• BIRMINGHAM**	32.0	32.0
	110.0	110.0

* AN 18 TRILLION BTU/YR MBG PLANT MAY BE BUILT IN MEMPHIS.

**BIRMINGHAM IS OUTSIDE THE TVA REGION.

EXPECTED MBG DEMAND BY THE PRIMARY METALS INDUSTRY

This chart illustrates the type of MBG demand data which TDC has developed for specific types of industry in this region. Primary metals industry is expected to be a large initial consumer of MBG.

EXPECTED MBG DEMAND
BY THE PRIMARY METALS INDUSTRY
(SIC 33)

LOAD CENTER	EXPECTED MBG DEMAND (TRILLION BTU/YR)
• CHATTANOOGA	0.717
• CENTRAL TENNESSEE	0.755
• NORTHEAST ALABAMA	4.391
• NORTHWEST ALABAMA	8.355
• HUNTSVILLE	0.0
• MEMPHIS	0.0
• NASHVILLE	0.0
• BIRMINGHAM	27.652
	41.870

EXPECTED MBG DEMAND BY THE CHEMICAL INDUSTRY

Chemical industry is expected to be an initial large consumer of MBG for process heating, and as a chemical feedstock. Total chemical industry expected consumption of natural gas and fuel oil in 1977 is 26,262 TBTU/YR.

EXPECTED MBG DEMAND
BY THE CHEMICAL INDUSTRY
(SIC 28)

LOAD CENTER	EXPECTED MBG DEMAND (TRILLION BTU/YR)
• CHATTANOOGA	8.619
• CENTRAL TENNESSEE	0.276
• NORTHEAST ALABAMA	0.746
• NORTHWEST ALABAMA	12.015
• HUNTSVILLE	0.318
• MEMPHIS	2.279
• NASHVILLE	2.009
• BIRMINGHAM	0.0
	26.262

EXPECTED MBG DEMAND BY THE RUBBER INDUSTRY

The rubber industry is also expected to utilize large amounts of MBG. In 1977, the estimated consumption is not very large compared to primary metals and chemicals. However, the rubber industry would be a good target for growth and expansion of energy useage.

EXPECTED MBG DEMAND BY THE RUBBER INDUSTRY (SIC 30)

LOAD CENTER	EXPECTED MBG DEMAND (TRILLION BTU/YR)
• Chattanooga	0.206
• Central Tennessee	1.361
• Northeast Alabama	2.724
• Northwest Alabama	0.0
• Huntsville	0.296
• Memphis	0.878
• Nashville	0.265
• Birmingham	0.0
	5.730

MEDIUM-BTU GAS APPLICATION

TDC concentrated on near-term utilization of MBG by industries. An attempt was made to estimate which industries would have the higher initial propensity to consume MBG. By using a high-low evaluation technique, chemicals, rubber, and primary metals are the main industries which would use MBG.

MEDIUM BTU GAS APPLICATION

SIC	INDUSTRY	FEASIBILITY	RETROFIT REQUIREMENT	GAS/OIL % COST OF SALES	COAL CONSUMPTION	ENERGY INNOVATION	INITIAL PROPENSITY TO CONSUME MEDIUM-BTU GAS
20	Food	Heating	Low	0.6	High	High	Low
22	Textiles	Heating	Low	1.0	High	Low	Low
26	Paper	Heating	Low	3.0	High	Low	Low
28	Chemicals	Feedstock Heating	High	2.6*	High	High	High
30	Rubber	Heating	High	2.3	High	High	High
32	Stone/Glass	Heating	Low	11.7	Low	Low	Low
33	Primary Metals	Ovens Reheating Melting	High	2.5 (Steel) 33.3 (Al)	High Low	High High	High High
34	Fabricated Metals	Heat Treating Drying	High	0.5	Low	Low	Low

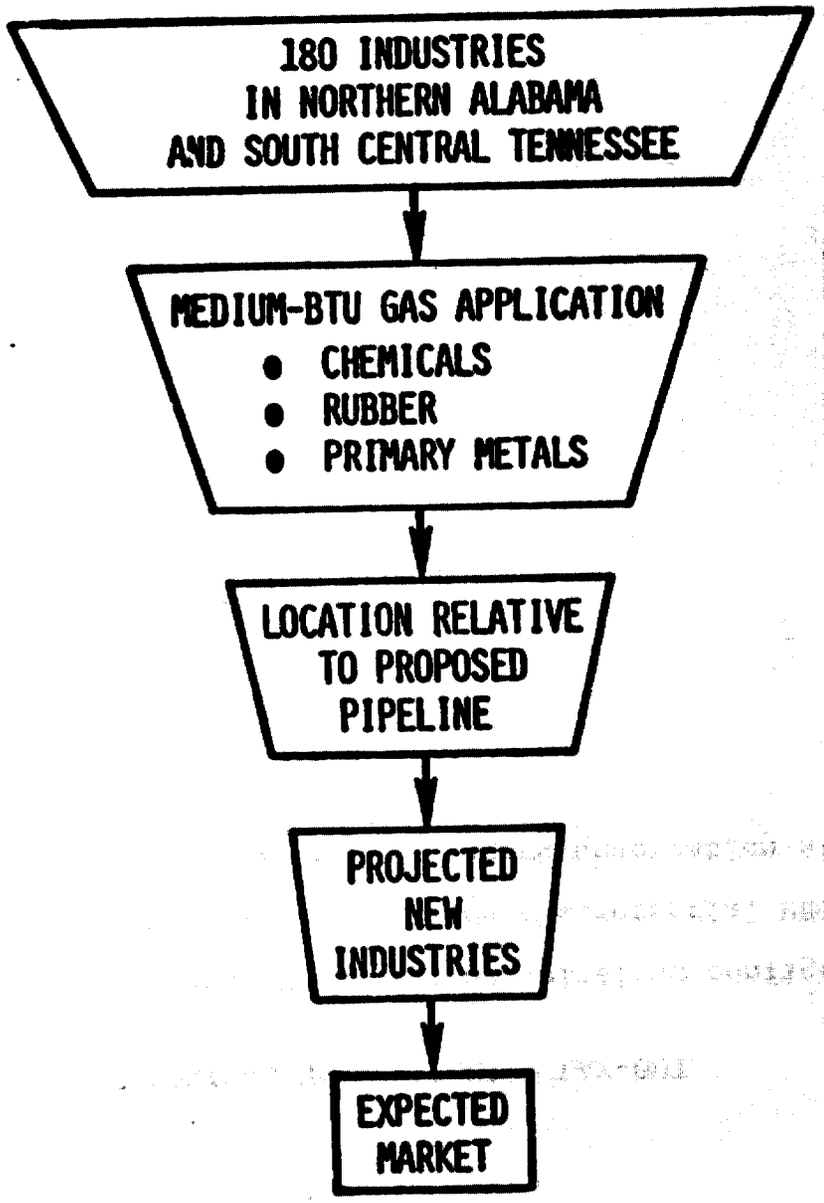
* Does not include feedstock.

** High consumption equals greater than 9% of total energy consumed.

MEDIUM-BTU GAS HIGH-LOW EVALUATION METHODOLOGY

For the 180 major industries in Northern Alabama and South Central Tennessee, the industry type and location relative to the proposed NASA pipeline were determined. If an industry was a chemical, rubber, or primary metals, and located within ten miles of the proposed NASA pipeline, the current total use of natural gas and fuel oil would be converted to MBG. Therefore, this methodology is a binary inclusion or exclusion of MBG. The expected value technique is a continuous method where all industries use some MBG.

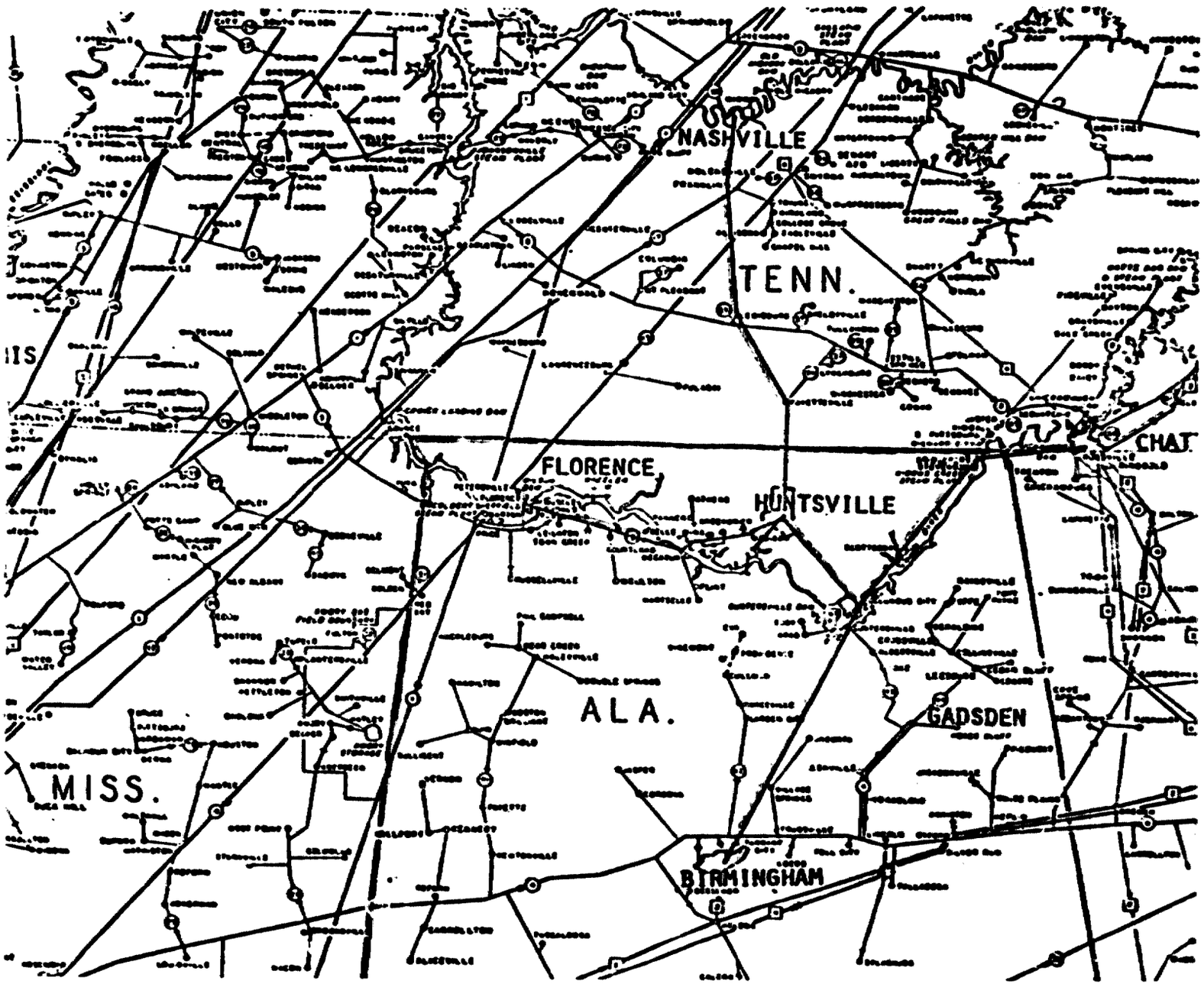
MEDIUM-BTU GAS HIGH-LOW EVALUATION METHODOLOGY



CANONICAL NASA PIPELINE LAY-OUT

This chart shows a proposed NASA regional pipeline configuration, originating at Murphy Hill, Alabama. TDC has investigated the potential MBG market along this pipeline utilizing the high-low propensity market penetration algorithm.

NASA/MURPHY HILL PIPELINE

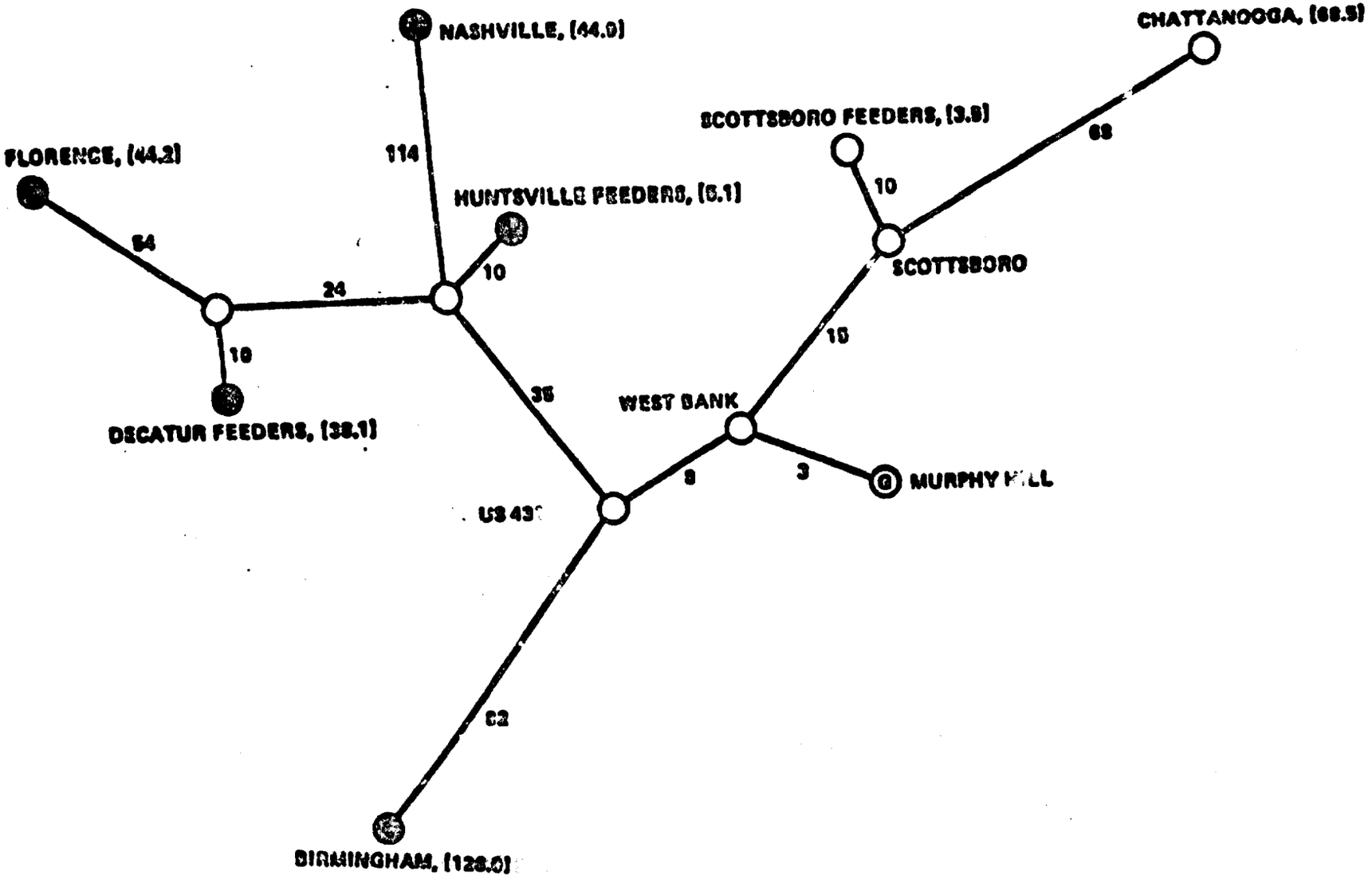


ORIGINAL PAGE IS
OF POOR QUALITY

MURPHY HILL GASIFIER SITE AND PIPELINE SCHEMATIC

NASA/MSFC developed a conceptual design for an MBG pipeline assuming the gasifier was located at Murphy Hill, Alabama. TVA provided estimates of load center energy useage to NASA which is depicted on the figure.

MURPHY HILL GASIFIER SITE AND PIPELINE SCHEMATIC

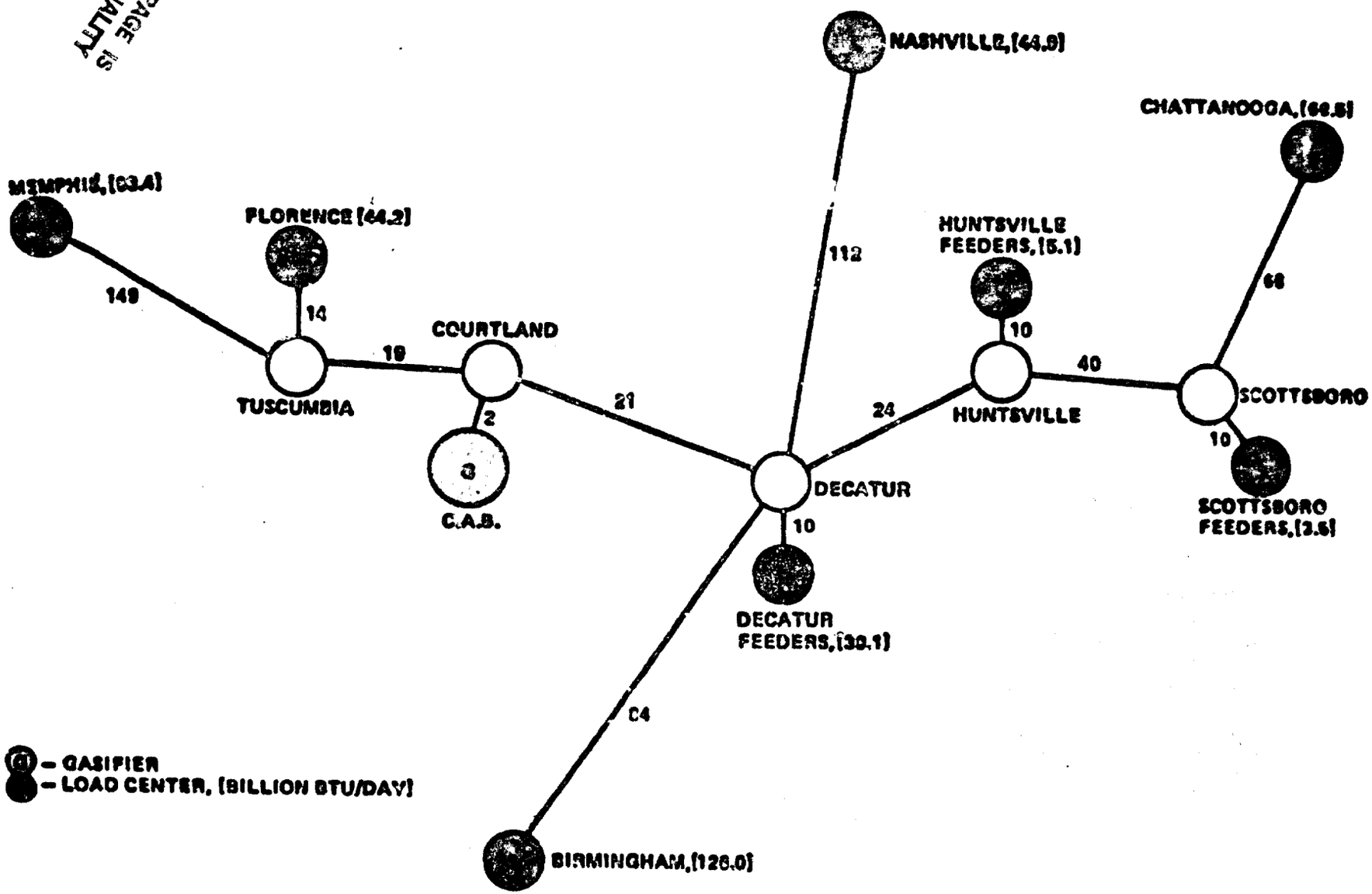


COURTLAND GASIFIER SITE AND PIPELINE SCHEMATIC

NASA/MSFC also analyzed a pipeline configuration with the gasifier located at Courtland. TVA provided load center data for MBG useage.

ORIGINAL PAGE IS
OF POOR QUALITY

COURTLAND GASIFIER SITE AND PIPELINE SCHEMATIC



MBG PIPELINE BRANCH ANALYSIS

Using the Murphy Hill pipeline configuration, TDC ascertained which industries were located "close" to the pipeline. Data from Gilbert Engineering indicated a pipeline branch of ten miles would cost almost nine million 1979 dollars. Therefore, a ten-mile branch would be a significant cost for one plant, indicating industries would have to be within ten miles of the pipeline to economically utilize MBG. However, if a plant would use greater than 7 TBTU/YR, it may be economical to extend a branch of the MBG pipeline.

MBG PIPELINE BRANCH ANALYSIS*

TRANSMISSION DISTANCE (Miles)	2	10
CAPACITY (BTU/Yr)	$\sim 7 \times 10^{12}$	$\sim 7 \times 10^{12}$
GAS PRESSURE	0 & 60	0 & 60
TOTAL CAPITAL COST (1978 $ Million)	1.258	8.817
NET OPERATING COST (1978 $ Million)	0.038	0.265
AVERAGE PRODUCT GAS COST ($/Million BTU)	0.02	0.14

* "Analysis of Gasifier Pressure Versus Gas Transmission Distance for Single Stage Fixed-Bed Gasifiers", Gilbert, Nov. 6, 1979.

MBG MARKET FOR HIGH-LOW EVALUATION TECHNIQUE

This chart summarizes the existing MBG market along the canonical NASA/MSFC Murphy Hill pipeline configuration, as determined by the high-low market penetration technique.

MBG MARKET FOR HIGH-LOW EVALUATION TECHNIQUE

LOAD CENTER	MBG MARKET (TRILLION BTU/YR)
• CHATTANOOGA	12.0
• CENTRAL TENNESSEE	0.2
• NORTHEAST ALABAMA	4.0
• NORTHWEST ALABAMA	22.0
• HUNTSVILLE	0.5
• MEMPHIS	0.0
• NASHVILLE	3.0
• BIRMINGHAM	30.0
	71.7

COMPARISON OF MARKET ESTIMATES

This chart shows the MBG market as calculated by the expected value and high-low market penetration techniques. Additionally, the total natural gas and fuel oil industrial markets are given for the various load centers, as computed by the Bureau of Census (1976 data) and as given by data furnished by TVA to NASA for the NASA pipeline study.

Therefore, a conservative estimate of 72 TBTU/YR and an optimistic 169 TBTU/YR market potential was ascertained.

COMPARISON OF MARKET ESTIMATES* (1977)
FOR NATURAL GAS AND FUEL OIL

LOAD CENTER	EXPECTED VALUE TECHNIQUE	HIGH-LOW TECHNIQUE	CENSUS BUREAU	NASA PIPELINE DATA
• CHATTANOOGA	17.0	12.0	24.0	25.0
• CENTRAL TENNESSEE	6.0	0.2	--	--
• NORTHEAST ALABAMA	15.0	4.0	11.0	4.0
• NORTHWEST ALABAMA	25.0	22.0	33.0	30.0
• HUNTSVILLE	1.0	0.5	3.0	2.0
• MEMPHIS	8.0	0.0	33.0	34.0
• NASHVILLE	6.0	3.0	16.0	16.0
• BIRMINGHAM	32.0	30.0	49.0	46.0
	110.0	72.0	169.0	157.0

* ALL NUMBERS ARE IN TRILLION BTU/YR.

MBG POTENTIAL CONSIDERING SIC AND NASA-MURPHY HILL PIPELINE

TDC prepared tables on 180 individual companies' natural gas and fuel oil useage in 1977. This data was forwarded to NASA and is not available for public use, since it may contain company proprietary data. Conclusions from this data, considering the pipeline concept, are shown on the facing page. Four large industries (Amoco, U.S. Steel, C.F. Industries, and Reynolds Metals) consume a major portion of the total energy useage in Northern Alabama and South Central Tennessee. The NASA pipeline study was conducted before load center analysis was complete; therefore, the pipeline could be re-routed optimizing industrial energy useage.

MBG POTENTIAL CONSIDERING SIC AND NASA-MURPHY HILL PIPELINE CONCLUSIONS

- Conservative Estimate of Total MBG Consumption of 71,697 BBTU/Yr.
- Four Large Industries Are Major Consumers of 51,481 BBTU/Yr.
- Northeast Alabama Load Center Can Be Expanded by Considering Gadsden.
- Nashville Is Small Load Center (2,952 BBTU/Yr) for Long Extension of Pipeline.
- Central Tennessee Load Center Can Be Expanded by Branch or Re-Route Pipeline Through Columbia-Mt. Pleasantville and Possibly Murfreesboro.
- Recommended Optimization of Pipeline Placement and Load Centers.

COAL GASIFICATION BY-PRODUCT UTILIZATION

TDC briefly determined by-product prices and uses which the facility could export or import (i.e., oxygen). In performing a detailed facility cost analysis, these by-products will have to be taken into account. Sulphur, steam, and carbon dioxide have the most potential for export to industries. Ash will probably have to be used as land-fill.

COAL GASIFICATION BY-PRODUCT UTILIZATION (1979 PRICES)

OXYGEN: USED IN PRIMARY METAL MANUFACTURING, HEALTH SERVICES, AND METAL FABRICATING; STEEL INDUSTRY LARGEST USER; CONSTANT GROWTH MARKET; 34¢ PER 100 FT^3 PLUS SHIPPING

NITROGEN: USED IN BLANKETING ATMOSPHERES - CHEMICAL PROCESSING, ELECTRONICS, PRIMARY METALS, FREEZING AGENTS; MARKET GROWTH 11% PER YEAR; 30.5¢ PER 100 FT^3 PLUS SHIPPING

CARBON DIOXIDE: USED IN FOOD REFRIGERATION AND BEVERAGE CARBONATION; MARKET CYCLICAL BUT UPWARD TRENDS; $60 PER TON

SULFUR: PHOSPHATE FERTILIZER DOMINATES USE, COULD BE USED AS SULFUR-ASPHALT BLEND; IMPORTS EXCEED EXPORTS BY .8 MILLION TONS PER YEAR; MARKET FLUCTUATES BECAUSE OF WORLD FERTILIZER USE; $60-$70 PER LONG TON

ASH: USED AS FILLER IN CONCRETE BLOCKS, ASPHALT ROADS, ROOFING FILLER, OR DUMPED; IN NEXT 10 YEARS COULD BE THE FOURTH MOST PLENTIFUL MINERAL IN U.S.

STEAM: BROAD INDUSTRIAL USE IN TEXTILES, PAPER, LUMBER, CHEMCIALS, METALS, ETC.; ~ 350°F; ~ $1.00/MILLION BTU (UTILITY-COAL BASED)

METHANE

Methane could be produced from one or several modules as a fuel. Methane is used extensively in producing fertilizer (ammonia) and methanol. Natural gas contains large amounts of methane and methane could be converted to synthetic natural gas by industries or utilities. Natural gas curtailment caused large increases in imported oil as a fuel substitute.

METHANE

- GREATEST USE FOR METHANE (~ 90%) IS FOR PRODUCTION OF AMMIONIA & METHANOL
- CHEMICAL INDUSTRY CRACKS METHANE WITH STEAM TO H_2, CO & CO_2 (MBG)
- SNG REQUIRES SHIFT CONVERSION AND METHANATION FROM MBG
- NATURAL GAS CURTAILED BY 3.2 QUADS IN 1977 (TOTAL U.S. INDUSTRIAL USEAGE 9.8 QUADS) - SHIFT INCREASED OIL IMPORTS BY ONE MILLION BARRELS PER DAY

METHANOL

Methanol is used extensively by the chemical industry as a feedstock for conversion to other products. It is formed into gasoline, fuel oil, or can be used as a fuel for combined cycle turbines. Methanol has been proposed as a gasoline substitute; however, it reacts with water and plastics.

METHANOL

- CAN BE USED AS GASOLINE SUPPLEMENT (10%), OCTANE BOOSTER, FORMED INTO GASOLINE, FUEL OIL, OR COMBINED CYCLE WITH TURBINES
- 66,700 BTU/GALLON - $6.90 PER MILLION BTU (1979) OR 46¢/GALLON
- GASOLINE - 135,000 BTU/GALLON @ 38¢/GALLON
  METHANOL - 85,000 BTU/GALLON @ $1.25/GALLON
- PRODUCTION 1.1 BILLION GALLONS - CAPACITY 1.25 BILLION GALLONS
- PRODUCERS: MONSANTO, DUPONT, TENNECO, ROHM & HAAS, GEORGIA PACIFIC, ETC.
- OIL AND METHANOL CAN USE SAME MODES OF TRANSPORTATION
- METHANOL CAN REACT WITH WATER TO FORM IMMISCIBLE BOTTOM LAYER; ALSO ATTACKS CERTAIN AUTOMOTIVE RUBBERS AND PLASTICS; TOXIC
- PROPOSED LEGISLATION FOR EXEMPTION OF FEDERAL TAXES ON GASOHOL AND INVESTMENT TAX INCENTIVES
- 25,000 TPD METHANOL (50,000 TPD COAL) ALASKA FACILITY UNDER DESIGN, SCHEDULED FOR OPERATION IN 1983

LIQUEFACTION PROCESSES

A possible alternative to gasification is liquefaction of coal. A brief survey of processes, efficiencies, products, and estimated production cost are shown. The Fischer-Tropsch is an older technology and SRC is currently under development. The liquefaction processes produce a variety of products from gasoline to fuel oils and naptha.

LIQUEFACTION PROCESSES

PROCESSES	LIQUID PRODUCTS EFFICIENCY*	PRODUCTS IN BARRELS PER DAY (20,000 TPD COAL INPUT)	ESTIMATED PRODUCTION AVERAGE COST PER BARREL (1978 $)
FISCHER-TROPSCH	32	15,680 GASOLINE 16,240 LPG 1,040 NO. 2 FUEL OIL 1,680 NO. 6 FUEL OIL	$20.80
M - GASOLINE	44	38,240 PREMIUM GASOLINE 4,560 LPG	$14.00 ($21.00 - DOE)
H - COAL - SYNCRUDE MODE	56	19,760 NAPTHA 29,120 SYNCRUDE	$12.60
H - COAL - FUEL OIL MODE	66	12,400 NAPTHA 41,040 NO. 6 FUEL OIL	$12.90
EXXON DONOR SOLVENT	65	22,000 NAPTHA 8,560 LPG 29,760 NO. 6 FUEL OIL	$13.60
SRC-I	70	10,400 NAPTHA 51,520 SOLID	$13.60
SRC-II	77	10,400 NAPTHA 5,120 NO. 2 FUEL OIL 42,320 NO. 6 FUEL OIL	$13.70

* EFFICIENCY DEFINED AS ENERGY VALUE OF LIQUID PRODUCTS DIVIDED BY ENERGY OUTPUT OF COAL AND REQUIRED ELECTRICAL POWER

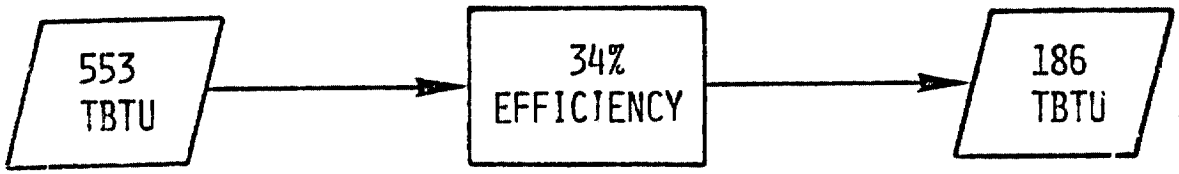
REFERENCE: "COMPARISON OF LIQUEFACTION PROCESS", K.A. RODGERS, ET. AL., ENGINEERING SOCIETIES COMMISSION ON ENERGY, INC.: FE-2468-25, WASHINGTON, D.C., APRIL 1978.

ENERY USE VERSUS ELECTRICITY

Electric utilities in Alabama use large amounts of coal to generate power. The average efficiency is fairly low (34%) as compared to fuel cells and MBG (55%). TVA is considering fuel cells as an alternative to selling MBG during peak load periods.

ENERGY USED VERSUS ELECTRICITY GENERATED

ALABAMA 1976

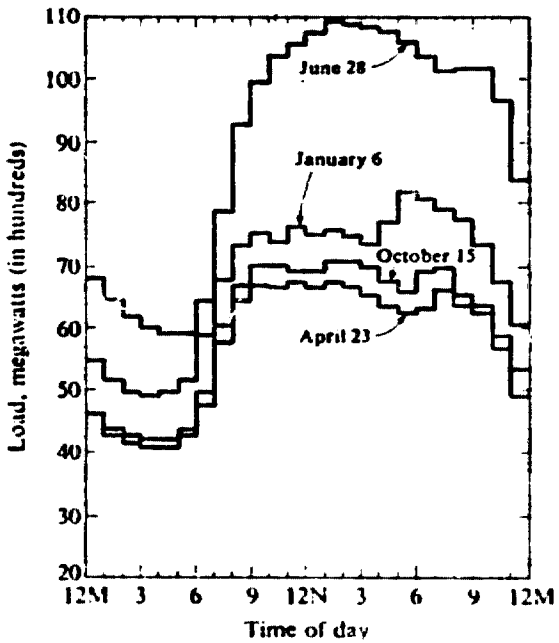


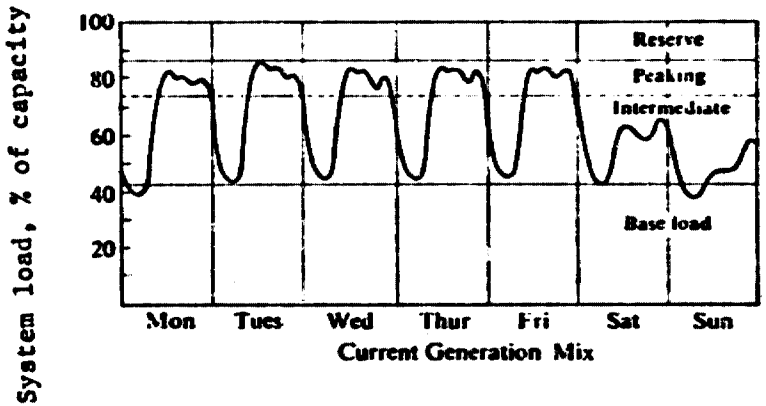
TYPE OF ENERGY	% OF TOTAL
COAL	73
HYDRO	18
NUCLEAR	8
NATURAL GAS	0.7

SYSTEM LOAD VARIANCE

Electrical load variances per day are shown to be between 40-80% of system capacity. Loads also vary by time of year because of weather, production schedules, holidays, etc. Again, fuel cells generating electricity from MBG fuel could be an attractive alternative.

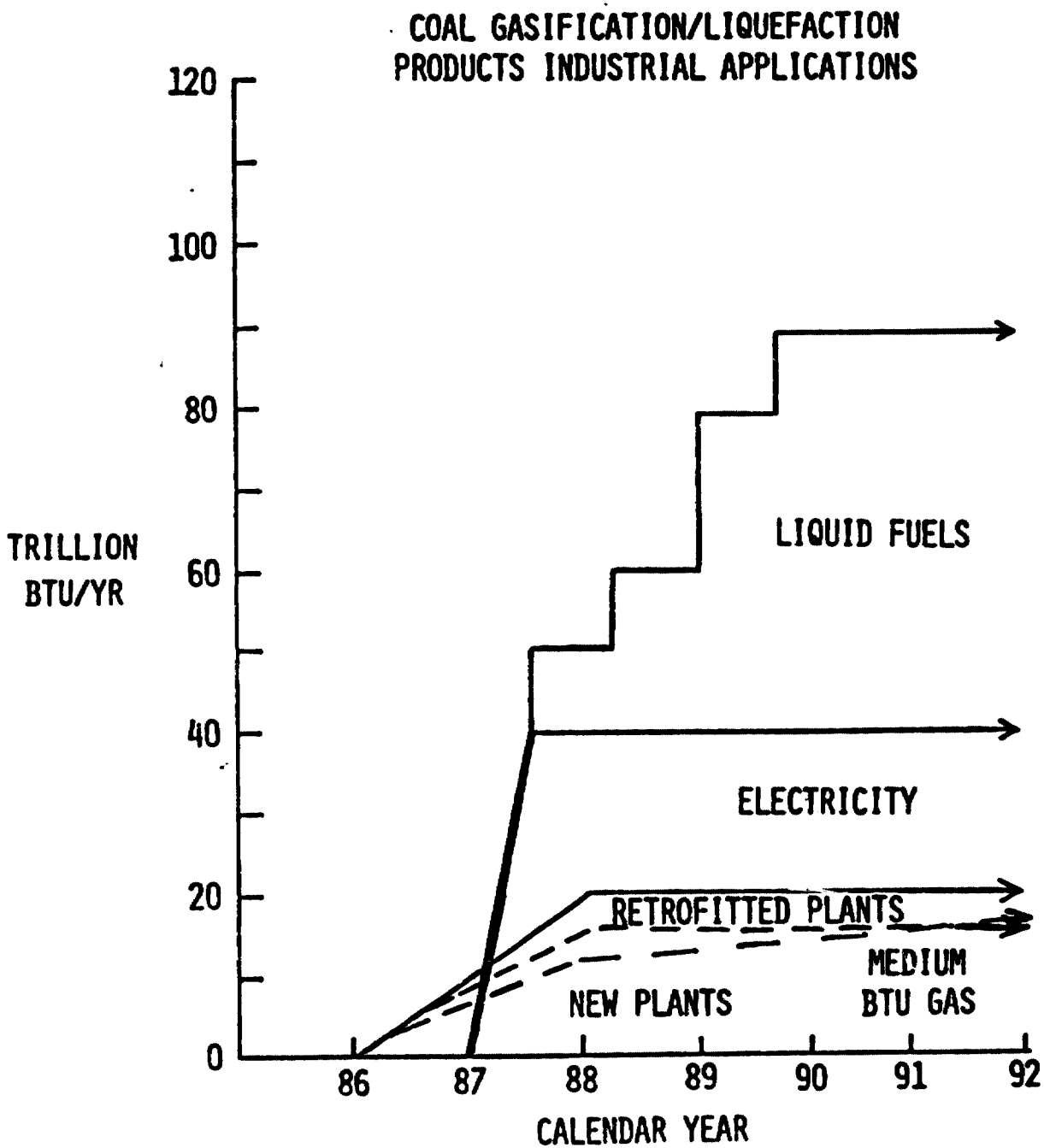
SYSTEM LOAD VARIANCE





COAL GASIFICATION LIQUEFACTION PRODUCTS INDUSTRIAL APPLICATIONS

Alternate gas and liquid products may be feasible for facility output. For medium-BTU gas, existing plants will require new pipelines and possibly burners for useage. New plants being constructed can build to use the MBG. Electricity for peak low requirements from fuel cells may be attractive. The liquid fuel market will probably have strong demand in the near future for gasoline and fuel oil. Different modules of the facility could use various processes or systems to produce alternate products during different months of the year.


COAL GASIFICATION/LIQUEFACTION
PRODUCTS INDUSTRIAL APPLICATIONS
TRILLION
BTU/YR
120
100
80
60
40
20
0
LIQUID FUELS
ELECTRICITY
RETROFITTED PLANTS
NEW PLANTS
MEDIUM
BTU GAS
86
87
88
89
90
91
92
CALENDAR YEAR

PROCESS/PRODUCT SUMMARY

A brief summary of three liquid processes, quantities produced, costs, and product value are illustrated. The value factor is a price relationship to premium gasoline at a point in time. The data shown in the table is from the Engineering Societies Commission on Energy (ESCOE) report entitled "Coal Conversion Comparisons", July, 1979.

PROCESS/PRODUCT SUMMARY

Process	Product Quantity/Day	Trillion BTUs/Yr	Value Factor	Capital Cost ($)	Utility Cost ($)	Operating/ Maintenance		Product ($/Million BTU)			
						Fuel Cost ($)	Operating Cost ($)	Cost		Value	
								Bill	Priv	Bill	Priv
Fischer-Tropsch	10,200 BBL Gasoline 10,800 BBL LPG 1,200 BBL No. 2 Oil 2,000 BBL No. 6 Oil 90.7 MMSCF MDG 37.2 MMSCF CO_2 Gas	89.4	0.9 0.86 0.82 0.56 1.00 1.00	688	433	246	109.0	4.99	5.41	5.52	5.99
Methanol	113,400 BBL Methyl Fuel 8,400 BBL Methanol	194.3	0.96 1.00	731	461	2[illegible]	111.2	4.17	4.76	4.54	4.95
M-Gasoline	52,700 BBL Premium Gas 7,300 BBL LPG	96.2	1.00 0.86	744	468	246	121.8	4.84	5.26	4.91	5.34

NOTES:
1. Plant Feed Rate = 25,000 TPD Dry Coal
2. Source data corrected to zero electric power requirement using 10,000 BTU/KWH for on-site generation
3. Products have been adjusted for source coal heating value of 11,200 BTU/LB-Day
4. MMSCF = Million Std Cubic Feet (20°C, 1 ATM)
5. 90% Plant Operating Factor
6. Mid-1978 $

CONCLUSIONS

TDC found that the current total industrial natural gas and fuel oil market is not significantly greater than the total Coal Gasification Facility output. Projected energy useage growth of 4-6% will be necessary to justify market penetration by MBG. Four major industries will have impact on industrial energy useage in this area. Only Chattanooga may be an attractive load center in Tennessee. Birmingham is not in the TVA service area, but is a major industrial energy center.

CONCLUSIONS

- Current North Alabama Market Could Absorb MBG Products from One Module
- Projected North Alabama Market Could Absorb MBG Output from Up to Three Modules
- Huntsville and Nashville Load Centers Are Relatively Small Industrial Energy Consumers
- The Birmingham Load Center Is By Far the Largest in the Region
- Four Companies Consume 51 Trillion BTU/Yr:
  - U.S. Steel, Birmingham
  - C.F. Industries, Chattanooga
  - Reynolds Metals, Sheffield
  - Amoco Chemical, Decatur
- On the Basis of Energy Consumption and Pipeline Distance from Murphy Hill, the Nashville and Memphis Load Centers May Be Unattractive
- In This Region, the Principal MBG Users Would Be the Basic Metal, Chemical, and Rubber Industries

SECTION 5. CHARACTERIZATION OF INDUSTRIES SURROUNDING CANDIDATE AREAS

NORTHERN ALABAMA COUNTY MANUFACTURING DATA

For ten counties in Northern Alabama, TDC compiled industrial characteristics. Major manufacturing products, value added per manhour, and county wood and mineral resources are illustrated. Energy intensive industries such as paper, aluminum, and tires pay lower salaries. Electronics industries pay significantly greater salaries, but use less energy. The primary minerals for industries in Northern Alabama are wood, stone, and gravel.

NORTHERN ALABAMA COUNTY
MANUFACTURING DATA

COUNTY	MAJOR MANUFACTURING PRODUCTS*	MANUFACTURING** VALUE ADDED PER MAN HOUR	PINE LUMBER (BOARD FT. X1000)	HARDWOOD LUMBER (BOARD FT. X1000)	MINERALS PRODUCED IN 1975 IN ORDER OF VALUE
Colbert	Tires, Auto Transmissions, Aluminum, Aluminum Sheets & Plates	$29	4100	4453	Stone, Asphalt, Sand & Gravel
Dekalb	Mobile Homes, Steel Truses, Cakes & Rolls	$27	122	1547	Coal, Stone
Franklin	Mens Slacks, Mobile Homes	$15	463	1827	Stone, Sand & Gravel, Coal, Ironore
Jackson	Carpet Yarn, Tire Yarn, Aluminum, Lighting Fixtures	$25	2255	7383	Coal, Stone
Lauderdale	Mens' Underware, Uniforms, Western Ware, Beef Processing	$23	3	683	-
Lawrence	Paper, Clothing	$ 8	1580	1631	Sand & Gravel
Limestone	Poultry Processing, Thermostats, Auto Steering Gear	$11	153	1883	-
Madison	Radio Clocks, Telephones, Printed Cloth, Electronics, Shoes, Electronic Components, Air Distribution Equipment, Farm Equipment	$61	235	3784	Stone, Sand & Gravel, Clay
Marshall	Clothing, Polyester Yarns, Shirts, Poultry, Electrical Components	$32	584	2223	Stone, Sand & Gravel, Clay
Morgan	Synthetic Fibers, Auto Electrical Parts, Plastic, Aluminum Tubing, Steel Reels, Barges	$54	4026	3480	Stone

*Employs 250 or more people

**For manufacturers with more than 20 people (1972)

NORTHERN ALABAMA COUNTY
POPULATION AND LABOR FORCE DATA

A large Coal Gasification Facility will require thousands of construction workers to build the plant. New, large industries attracted by the sure supply of energy will require numerous employees. Therefore, the labor force in Northern Alabama will be heavily impacted. In general, Northern Alabama is a rural farming area where workers travel outside their county of residence to work, Madison County being the exception. Some of the current laborers will change jobs or be retrained. However, tens of thousands of new workers will immigrate to Northern Alabama for the construction of the facility and associated transportation equipment, and for the new industries attracted to the area. Counties like Marshall, Lawrence, and Limestone will have large population increases.

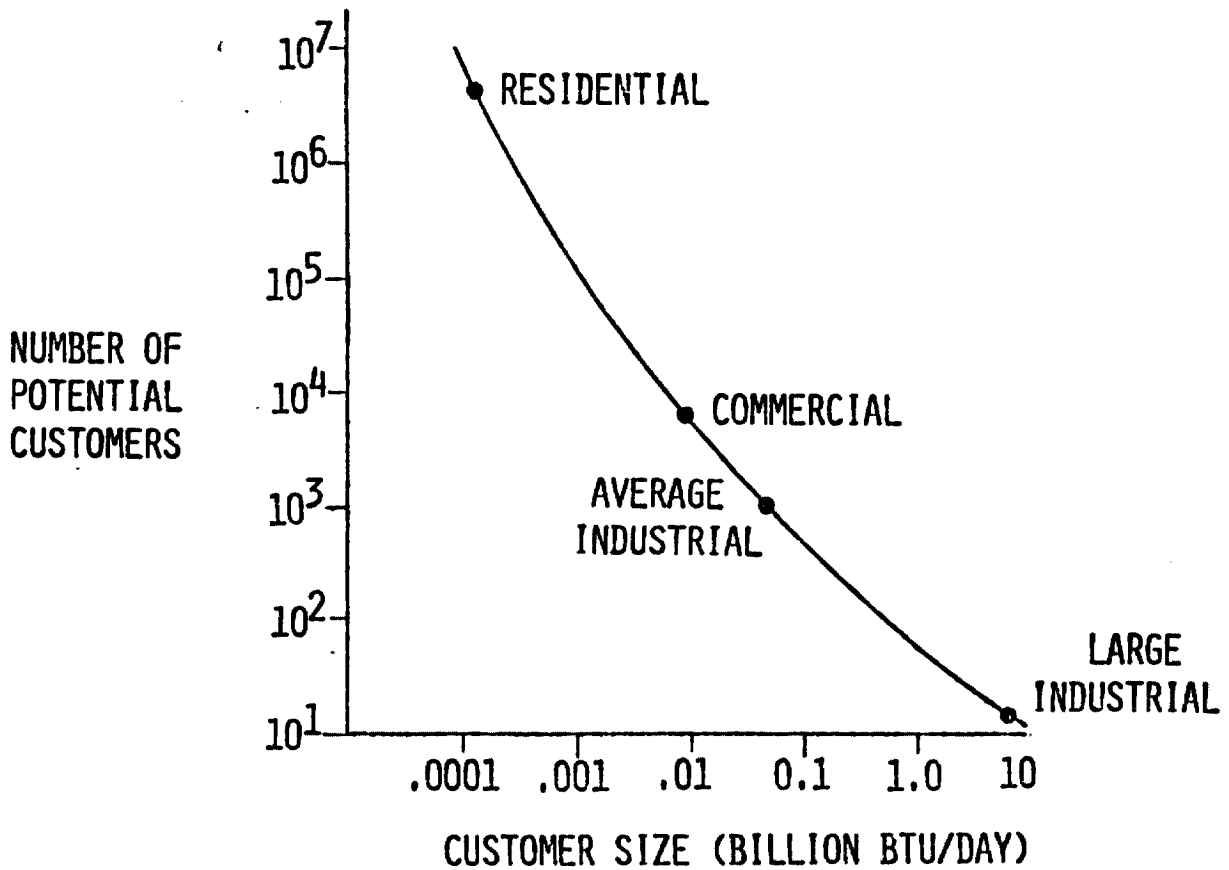
NORTHERN ALABAMA COUNTY
POPULATION AND LABOR FORCE DATA

POPULATION (X1000)				TOTAL EMPLOYMENT (X1000)					
COUNTY	1970	1980	1990	TOTAL	MANUFAC-TURING	TRANSPORTATION, COMMUNICATIONS, & UTILITIES	MINING	CONSTRUCTION	PERCENT WORKING OUTSIDE COUNTY OF RESIDENCE (1970)
Colbert	49.5	56.0	67.1	16.9	8.6	.8	-	1.3	19.2
Dekalb	42.0	46.1	50.7	13.1	4.2	.3	-	.2	26.1
Franklin	23.9	27.4	30.4	8.5	2.2	.1	.04	.09	28.9
Jackson	39.2	48.3	45.0	15.9	5.4	.2	-	.8	23.2
Lauderdale	68.1	76.7	88.6	24.6	2.9	.5	-	1.1	27.4
Lawrence	27.3	28.1	31.1	6.0	1.3	.06	-	.3	47.6
Limestone	41.7	51.0	63.7	10.0	1.5	.06	-	1.1	37.2
Madison	186.5	199.2	250.9	69.3	13.1	1.5	-	2.3	3.3
Marshall	54.2	72.0	95.2	19.8	5.7	.4	-	1.2	26.5
Morgan	77.3	88.3	104.1	29.1	10.4	1.2	.17	2.6	18.8

NATURAL OR SYNTHETIC GAS MARKET

As was shown in previous sections, new industries consuming 50-100 total trillion BTU per year may be necessary to justify the facility. Current industries may not retrofit or be able to 100% convert to synthetic fuels. Therefore, new industries moving to the Tennessee Valley will have to be large energy consumers (>1 TBTU/YR), and in significant numbers (50-100).

NATURAL OR SYNTHETIC GAS MARKET



INDUSTRIAL ENERGY CHARACTERISTICS

Industries in this area are large energy consumers when compared to national averages. As was shown earlier, four large industries in Northern Alabama, Birmingham, and Chattanooga consume over 50 TBTU/YR. Forty-one industries in Alabama and Tennessee consume over 1 TBTU/YR in natural gas and fuel oil. Primary metals, paper, and chemicals industries use large amounts of energy per unit of output.

INDUSTRIAL ENERGY CHARACTERISTICS

SIC CODE	INDUSTRY	AL/TN PLANT RANGE ($\times 10^{12}$ BTU/YR)	NATIONAL AVERAGE PLANT ($\times 10^{12}$ BTU/YR)	ENERGY/ UNIT PRODUCT (BTU/UNIT)	NUMBER OF PLANTS IN AL & TN WHICH USE > 10^{12} BTU/YR IN NATURAL GAS & PETROLEUM
28	Chemicals	2.85 - 5.75	.213	8.19×10^{6}/t (Inorganic)	6 (Ammonia)
33	Primary Metals	3.05 - 31.07	.299	6.82×10^{7}/t (Steel)	5
				2.55×10^{8}/t (Aluminum)	4
29	Petroleum	.75 - 5.3	. 75	1.51×10^{5}/t	1
26	Paper	1.37 - 3.92	.198	2.18×10^{7}/t	18
32	Stone, Clay, Glass	2.2 - 2.4	.076	1.36×10^{4}/t (Glass)	7 (Cement)
20	Food	N/A	.032	5.46×10^{6}/t	0

CHARACTERIZATION OF INDUSTRIES

The listed industries are the industries which probably would have a propensity to consume synthetic fuels. TDC assimilated extensive amounts of data on these industries, and the data is available upon request.

CHARACTERIZATION OF INDUSTRIES (SIC CODE)

Meat Packing	(2011)	Synthetic Rubber	(2822)
Fluid Milk	(2026)	Man Made Fibers	(2823)
Canned Fruits	(2033)	Petroleum Refining	(2911)
Frozen Vegetables	(2037)	Basic Glass	(3211)
Prepared Feeds	(2042)	Hydraulic Cement	(3241)
Bread and Cake	(2051)	Brick and Clay Tile	(3251)
Pulp and Paper Mills	(2611)	Ready Mixed Concrete	(3273)
Solid Fiber Box	(2653)	Lime	(3274)
Building Paper	(2661)	Blast Furnaces and Steel	(3312)
Alkalines and Chlorine	(2812)	Electrome Tallurgical	(3313)
Industrial Glass	(2813)	Gray Iron and Steel Foundries	(3321)
Crude Processing	(2815)	Copper Rolling & Drawing	(3351)
Industrial Organic	(2818)	Nonferrous Wire Drawing	(3357)
Plastics and Resins	(2821)	Aluminum	(3334)
		Iron and Steel Forgings	(3391)

BLAST FURNACES AND STEEL MILLS (3312)

The largest consumer of energy in this region is U.S. Steel in Birmingham. Characteristics of blast furnaces and steel mills are shown. Energy uses are depicted as well as an overview of processes.

BLAST FURNACES & STEEL MILLS (3312)

- LARGE, VERTICALLY INTEGRATED MILLS PERFORM FOUR MANUFACTURING OPERATIONS: COKE OVENS, BLAST FURANCES, STEEL WORKS, AND ROLLING MILLS
- PURCHASED COAL PRODUCES COKE, BREEZE, GAS, AND BY-PRODUCTS
- INDUSTRY HIGHLY CYCLICAL IN PRODUCTION
- MOST OF ENERGY USED IS COAL PROVIDED; NATURAL GAS DECLINING, ELECTRICITY INCREASING
- ENERGY/OUTPUT RATIO DECLINING BY 8% PER YEAR
- ENERGY-SAVING IMPROVEMENTS: BETTER CHARGE PREPARATION AND FUEL INJECTION FOR BLAST FURNACES; DEVELOPMENT OF TOP OXYGEN-BLOWN CONVERTER PROCESS; DEVELOPMENT OF CONTINUOUS PROCESSES FOR CASTING, ROLLING AND FINISHING
- SOAKING PITS HEAT INGOTS BEFORE ROLLING
- SOAKING PITS USE: COKE-OVEN GAS; NATURAL GAS; COKE-OVEN GAS PLUS BLAST FURNACE GAS; COKE-OVEN GAS PLUS NATURAL GAS; BLAST FURNACE GAS PLUS NATURAL GAS
- OIL USED AS STANDBY FUEL
- RE-HEAT FURNACES USE FUEL OIL, COKE-OVEN GAS, AND NATURAL GAS
- HEAT TREATING FURNACES PRIMARILY USE NATURAL GAS BECAUSE OF QUALITY REQUIREMENTS

INDUSTRIAL RETROFIT REQUIREMENTS

Industrial retrofit requirements were not part of the TDC scope of work. However, TDC feels this is a very important issue which should be examined. TVA and NASA are attempting to commercialize medium-BTU gas (MBG). This would require a new infrastructure similar to the natural gas market. As was shown in preceding sections, four large industries could consume half of the facility's output. Industries using MBG would have to retrofit current burners or processes which could cost significant amounts of dollars and production down-time. Industries would only convert to MBG if it were economically feasible and they would be assured of a continuous competitive fuel.

INDUSTRIAL RETROFIT REQUIREMENTS

- COMMERCIALIZE MBG
- CONVINCE OR "FORCE" A FEW SOPHISTICATED CUSTOMERS TO UTILIZE MBG
- DETERMINE PLANT EQUIPMENT SPECIFIC REQUIREMENTS
- ASCERTAIN PRODUCTION INTERRUPTION PERIOD
- CONVINCE CUSTOMER AND BE WILLING TO SIGN CONTRACTS THAT MBG WILL NOT ESCALATE THE SAME RATE AS FOREIGN FOSSIL FUELS
- CUSTOMERS WILL PERCEIVE DIFFERENCE BETWEEN MBG AND SNG OR NATURAL GAS

SECTION 6. CONCLUSIONS AND RECOMMENDATIONS

SUMMARY OF FINDINGS

TDC concluded the current market for medium-BTU gas (MBG) ranges from 72 to 169 TBTU/YR. Analysis of 180 specific plants in the area indicated a market of 110 TBTU/YR. The gasification facility would produce an amount of MBG which would saturate the current demand for natural gas and fuel oil. This assumes a large conversion and retrofit of current industries to MBG.

SUMMARY OF FINDINGS

- Madison County Survey Revealed No Industrial Energy Consumers Who Consumed One Trillion BTU/Yr or More
- Regional Census Bureau Energy Consumption Data Indicated a Potentially Large MBG Market Up to 169 Trillion BTU/Yr
- TDC Detailed Analysis of 180 Specific Plants, Selected from 1,200 Companies, Indicated a Region-Wide Market for Medium-BTU Gas Up to 110 Trillion BTU/Yr
- Total Projected Output, in BTU's, from the Gasification Facility Is a Very High Percentage (approx. 71%) of the Historical Natural Gas and Fuel Oil Market in This Region

CONCLUSIONS

In this region, principal MBG users would be primary metal, chemical, and rubber industries. Four companies have a critical impact on the potential size of the market. The current North Alabama market is not a major industrial center. New industries would have to be located here to justify the large production of MBG. Alternatively, a mix of gases, liquids, and electricity may be attractive from an economical and load-factor sense.

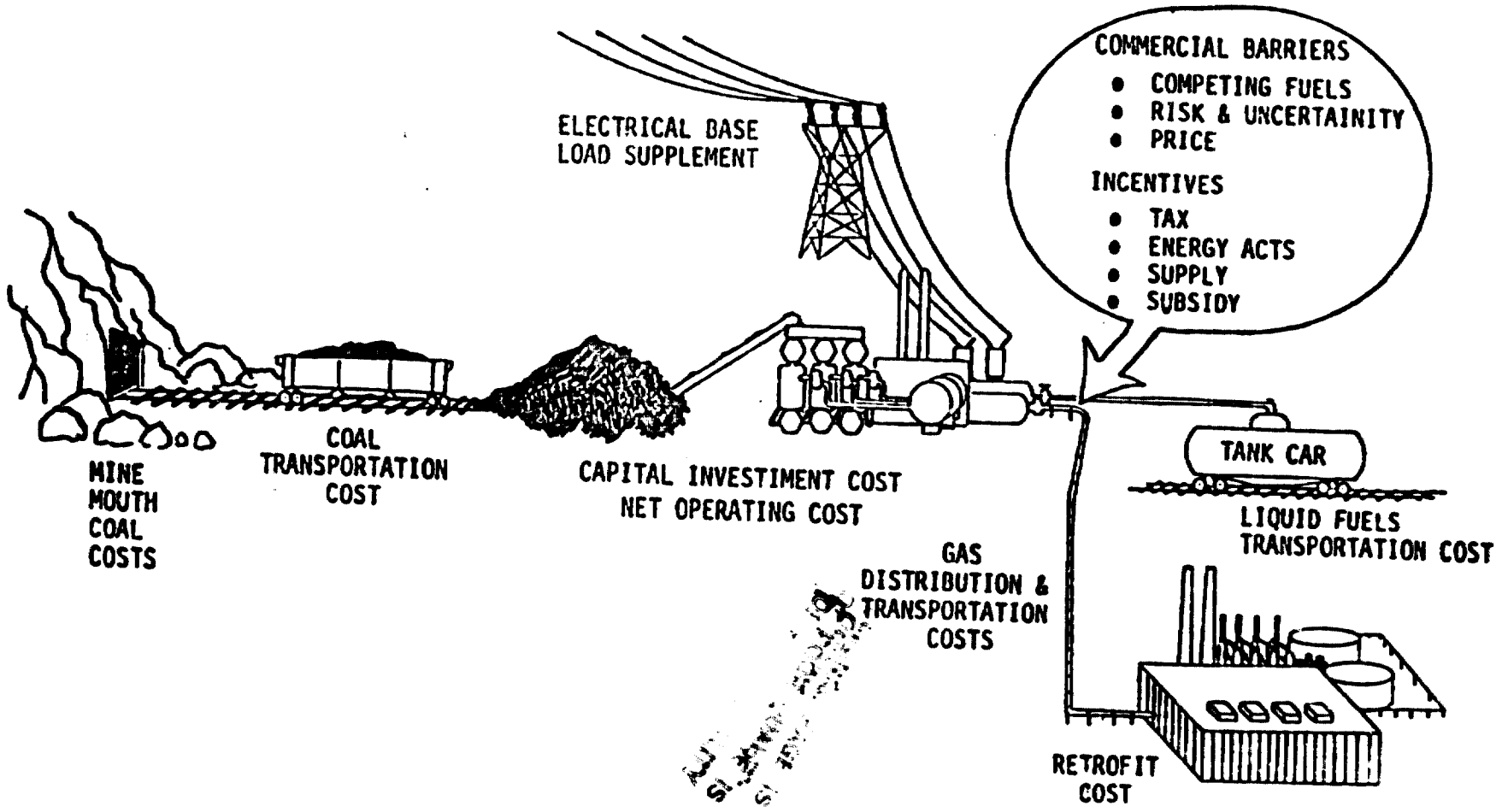
CONCLUSIONS

- In This Region, the Prinipal MBG Users Would Be the Basic Metals, Chemical, and Rubber Industries
- Four Companies Have a Critical Impact on the Potential Size of the Regional MBG Market (50% of Market)
  - U.S. Steel, Birmingham
  - Reynolds Metals, Sheffield
  - Amoco Chemical, Decatur
  - C.F. Industries, Chattanooga
- Current North Alabama Market Can Absorb MBG Production from One Module
- Projected North Alabama Market Can Absorb MBG Production from Three Modules
- New Industries Could Absorb MBG Production from Fourth Module
- Alternatively, Fourth Module Could Produce Synfuels Other Than MBG
- Possibility of Mix of Gaseous, Liquid, and Electrical Products from Facility

COAL UTILIZATION COST AND SYSTEMS ANALYSIS

A complete analysis of the industrial application of synthetic fuels would include the cost and economics of fuels. This would involve cost analysis of coal, facility, transportation, and plant retrofit costs. Industries will only use the synthetic fuels if the supply and price is competitive with conventional fuels. Commercial barriers and government incentives will also be involved in the marketing of synfuels. Since the facility under consideration is not designed, parametric trade-off analysis of systems and processes will have to be performed to optimize facility size and products with the market place.

COAL UTILIZATION COST AND SYSTEMS ANALYSIS



RECOMMENDED ADDITIONAL TASKS

TDC recommends four major tasks: cost and economic analysis; systems characterization; advanced technology of power systems; and, model development for product mixes, transportation, and costing. TVA and NASA are pursuing these tasks through in-house efforts and through contractors. However, planning of tasks and program objectives is not complete at this time.

RECOMMENDED ADDITIONAL TASKS
COAL GASIFICATION/SYNTHETIC FUELS PRODUCTION FACILITY

- Cost & Economic Data Collection
  - Capital Investment
  - Operating
  - Transportation & Distribution
  - Competing Fuels & By-Products
  - Financing Techniques
  - Benefits Assessment
  - Industrial Retrofit
- Gasification/Liquefaction Systems Characterization & Cost Estimate
  - Process Selections
  - Systems/Subsystems Definition
  - Parametric Cost Estimates
- Advanced Technology Power Generation Systems Characteristics/Cost Estimates
  - Fuel Cells (Co-Generation)
  - Closed/Open Cycle Systems
  - MHD Generators
- Facility, Transportation, & Industrial Applications Modeling
  - Existing Models/Methodologies
  - Model Development
  - Model Implementation
  - Life Cycle Costing for Facility Sizes & Product Mixes