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MINNESOTA'S ENERGY FUTURE

A Presentation for the
Legislative Commission on Energy

April 1975

Minnesota Energy Agency
Research Division
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MINNESOTA'S ENERGY FUTURE

RESEARCH DIVISION

REPORT

April 22, 1975

I. Division Responsibilities

II. Energy Supply And Use Patterns

III. Supply Situation In Short Term

IV. Response to Foreseen Shortfall in Energy Supply

V. Supply Options

VI. Demand Options

VII. Economic Impacts

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RESEARCH DIVISION RESPONSIBILITIES

A. Analysis of Energy Supply and Use Patterns

- Annual Statewide Energy Supply and Use Audit
- Current Energy Supply and Use Statistics (REIS)
- Future Supply Scenarios by Fuel
- Future Use Scenarios by End Use Sector
- Response to Shortfall

B. Economic Impact Studies

- Impact of President Ford's Proposed Energy Program On Minnesota
- Impact of Changes in Natural Gas Prices or Supplies On Minnesota Economy
- Impact on Energy Requirements of Changes in Economic Activity

C. Evaluation of Suggested Options

- Supply
  - (Alternative fuels, - Additional Generation Facilities, Solar etc.)
- Demand
  - Statewide Effect of Proposed Conservation Programs
  - Price Impacts
  - Mandatory Vs Voluntary Programs
  - Legislative Program Impacts
  - Energy Management for Maximum Employment, Economic Activity, etc.

Figure One

Minnesota's Conventional Energy Supplies 1965 to 1985

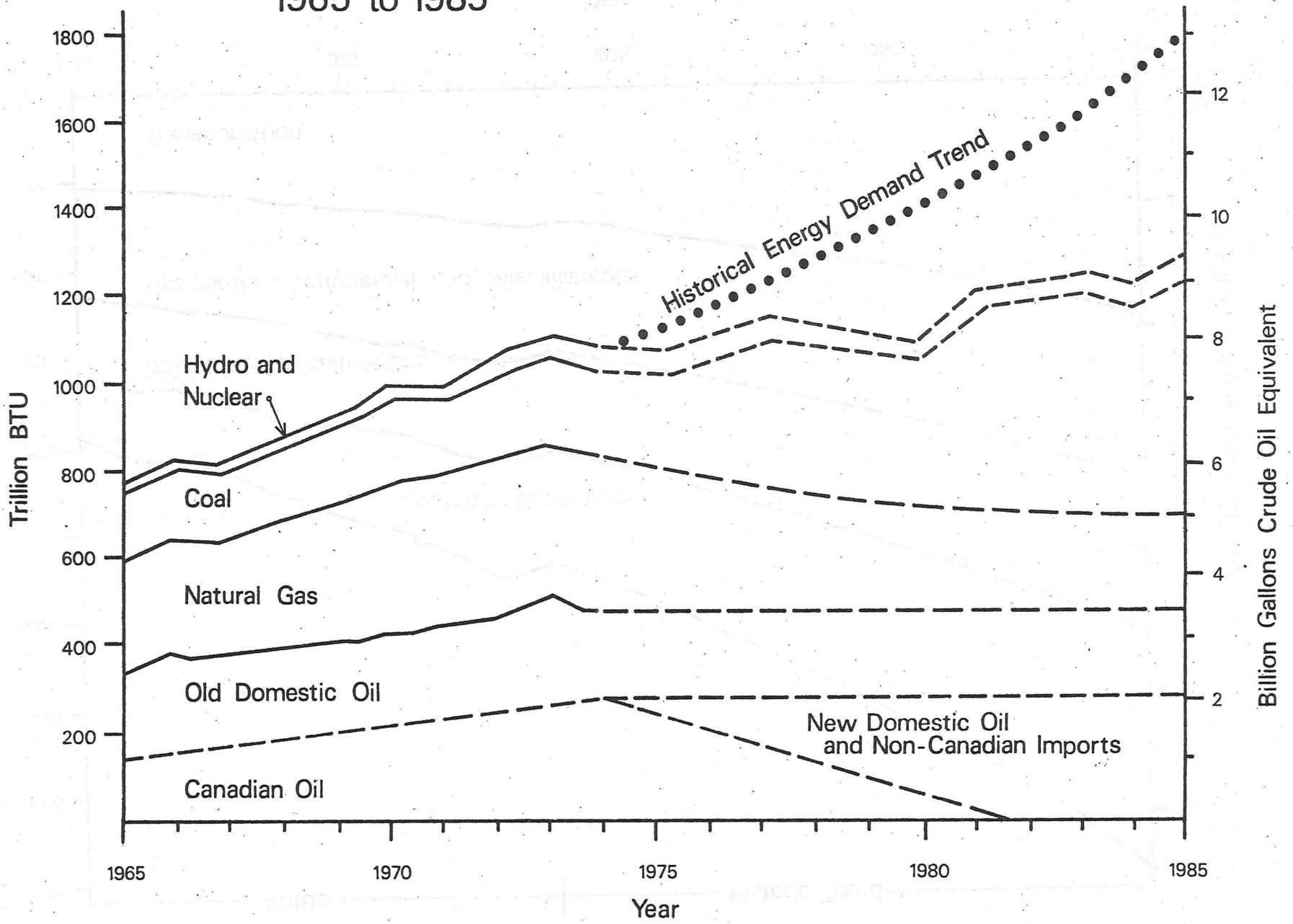


Figure Two

Minnesota's Demand for Primary Fuels 1965 to 1985

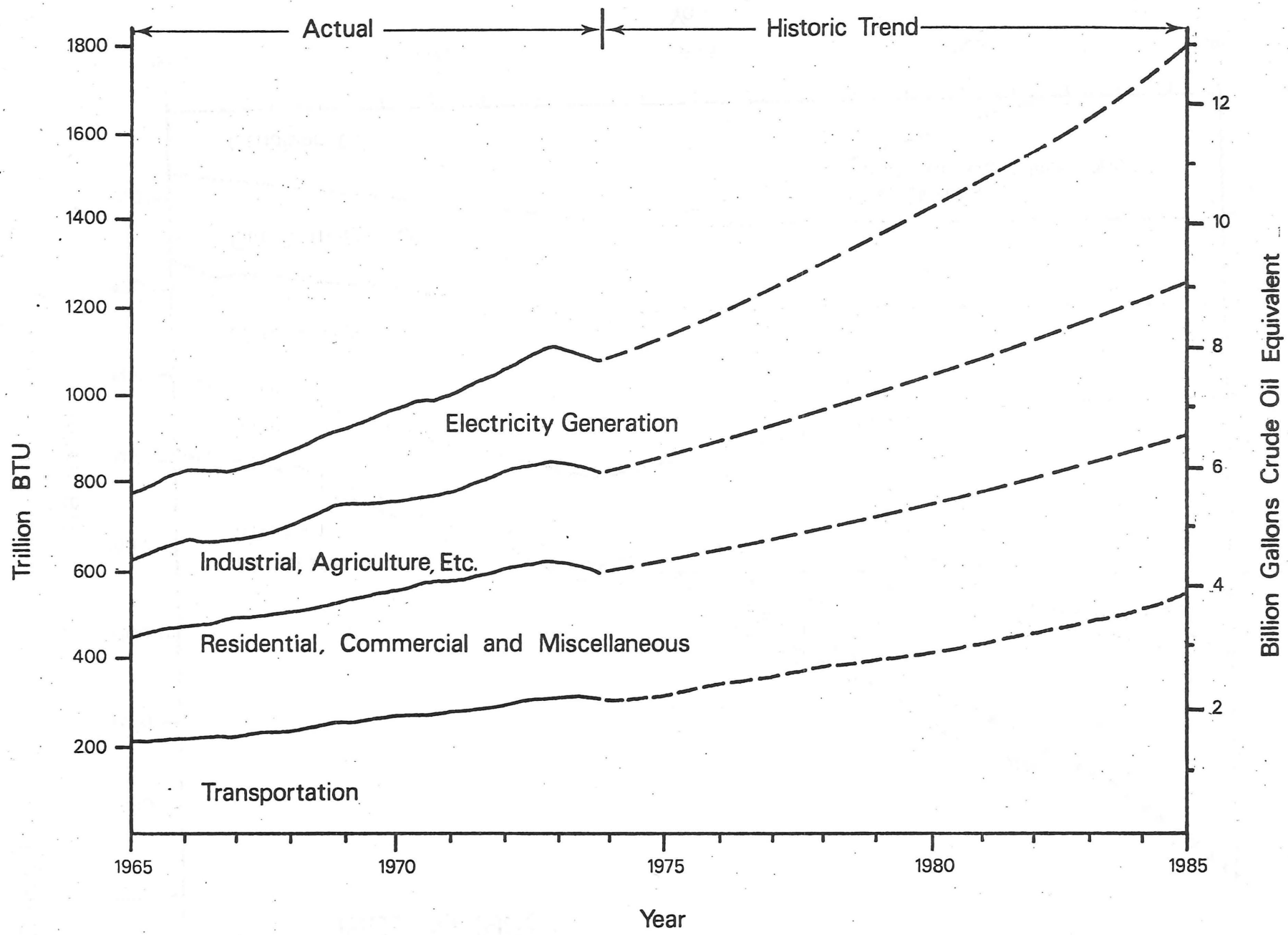
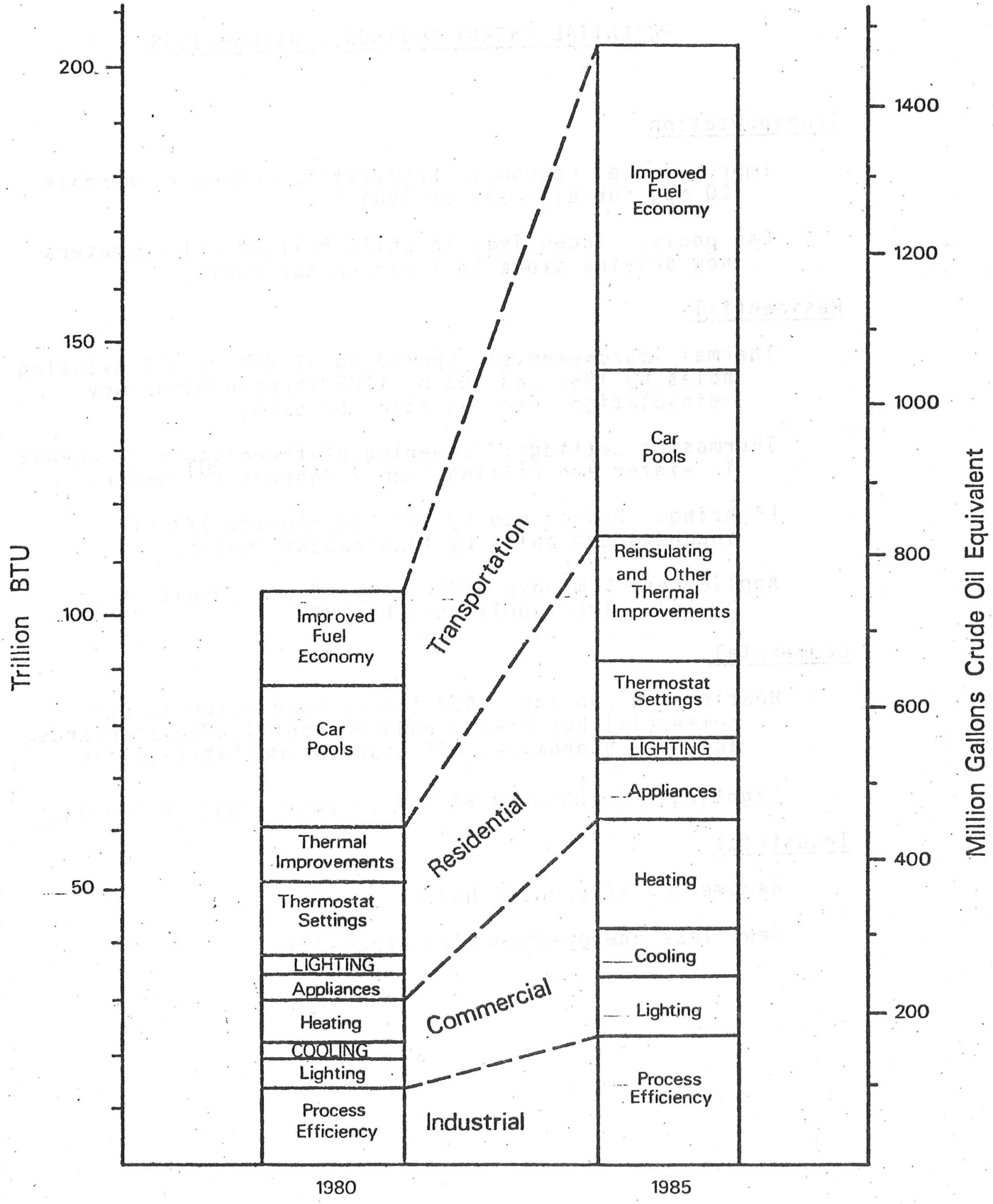


Figure Three

Some Potential Energy Savings for Minnesota 1980 and 1985



POTENTIAL ENERGY SAVINGS - ASSUMPTIONS

Transportation

Improved fuel economy: Legislative action to mandate 20 mpg for all cars by 1985.

Car pools: Incentives to shift half of all commuters now driving alone to 3-person car pools.

Residential

Thermal improvements: Upgrading of 40% of all existing homes by 1980 and 60% by 1985 through mandatory reinsulation, etc. at point of sale.

Thermostat settings: Lowering of thermostats 2 degrees in winter and raising them 2 degrees in summer.

Lighting: Reduce use by 10% and replace 1/3 of incandescent bulbs by fluorescent lights.

Appliances: Improve efficiency of air conditioners by 25%, other appliances by 10%.

Commercial

Heating and cooling: Additional insulation in new commercial buildings, reduced ventilation standards, and more economical off-hour thermostat settings.

Lighting: Cutback to 65% of current lighting levels.

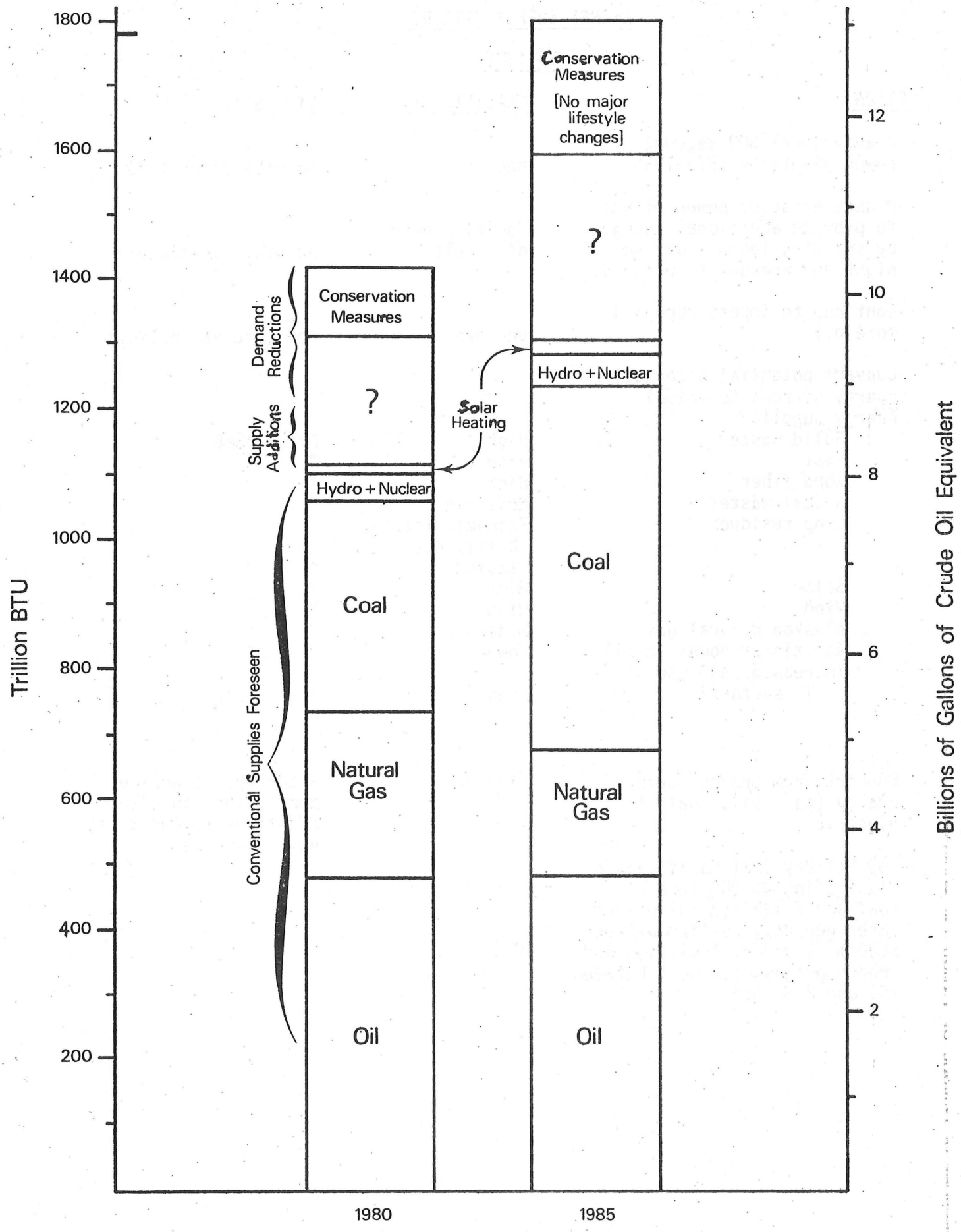
Industrial

Recovering of process heat.

New, less energy-intensive processes.

Figure Four

Balancing Minnesota's Energy Supply and Demand 1980 and 1985

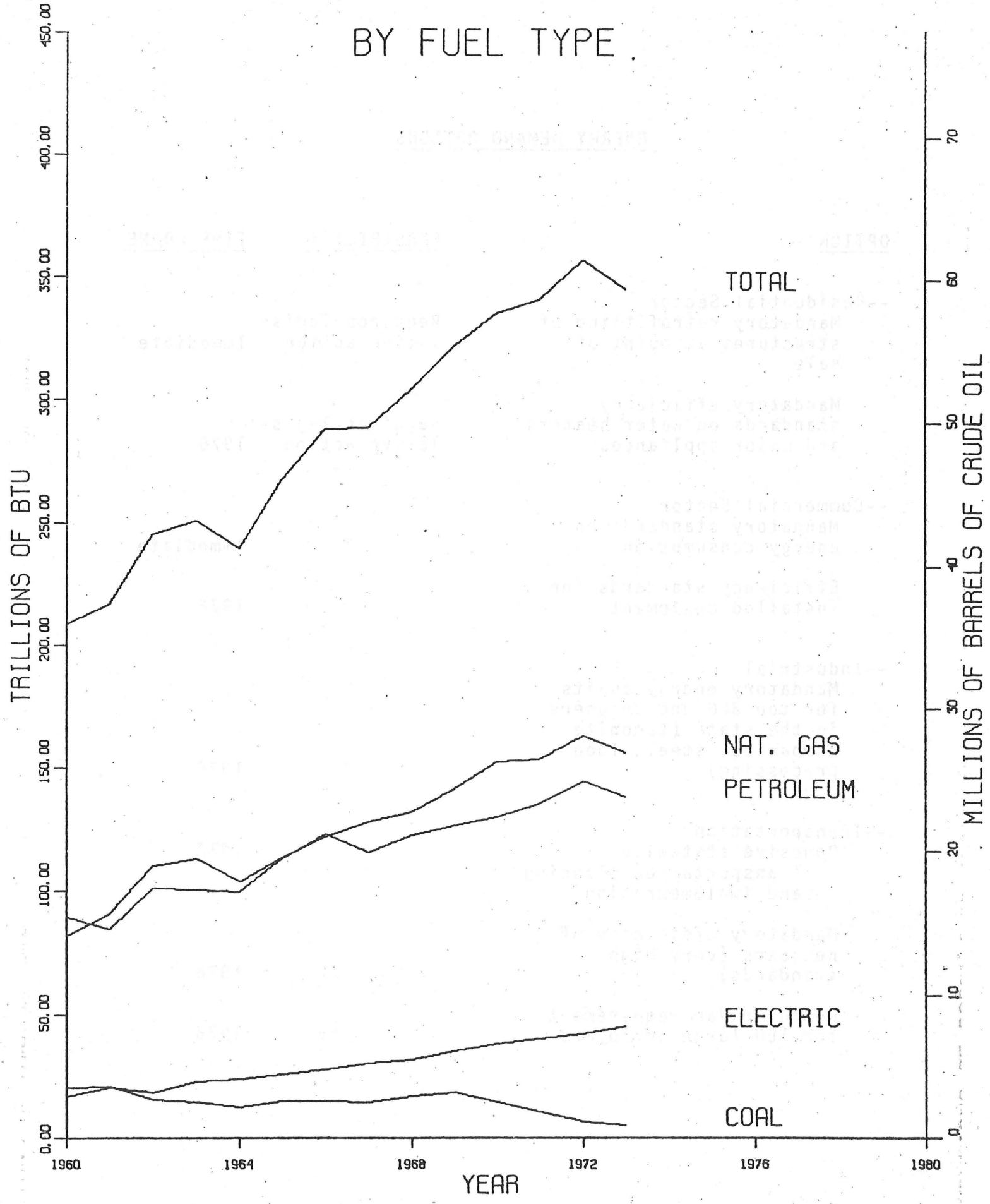


ENERGY SUPPLY OPTIONS

TO 1985

OPTION	FEASIBILITY	TIME SCALE
--2 additional 500 megawatt power plants by 1978-1980	None	Helpful after 1980
--Manage existing power plants to provide additional energy by shifting loads - day to night and weekday to weekend	Socially very difficult	Helpful immediately
--Continue to import more and more oil	Unknown	Now (present policy)
--Convert potential alternative energy sources to actual energy supplies:		
Solid waste	High	After 1980
Peat	High	" "
Wood fiber	High	" "
Animal wastes	Moderate	" "
Crop residues	Economic feasibility not tested	" "
Solar	High	" "
Wind	High	" "
Alaskan natural gas	Moderate	" "
Additional domestic oil	Low	" "
Increased coal use by all sectors	High	" 1979
--Convert from present primary energy (gas, oil, coal) to electric	High	After 1980 (Requires generation capacity additions beyond those now planned.)
--250 Mcf/Day Coal Gasification Plant using 25,000 tons of coal and 7 million gallons of water per day, costing between $600 million and 1 billion and producing gas at a cost between 1.60 and 2.50/Mcf	High	1981

MINN. ENERGY USE- RES. AND COM. BY FUEL TYPE



ENERGY DEMAND OPTIONS

OPTION	FEASIBILITY	TIME FRAME
--Residential Sector		
Mandatory retrofitting of structures at point of sale	Requires legislative action	Immediate
Mandatory efficiency standards on water heaters and major appliances	Requires legislative action	1976
--Commercial Sector		
Mandatory standards on energy consumption	"	Immediate
Efficiency standards for installed equipment	"	1976
--Industrial		
Mandatory energy audits for top 300 energy users in the state (taconite companies, steel, food processing)	"	1976
--Transportation		
Cohesive statewide Transportation planning and implementation	"	1976
Mandatory efficiency of new cars (very high standards)	"	1976
Commuter Van requirement for 100 large employers	"	1976

Per Cent Costs of Minnesota Manufacturing Shipments - 1971[4]
(11.1 billion 1971 dollars total)

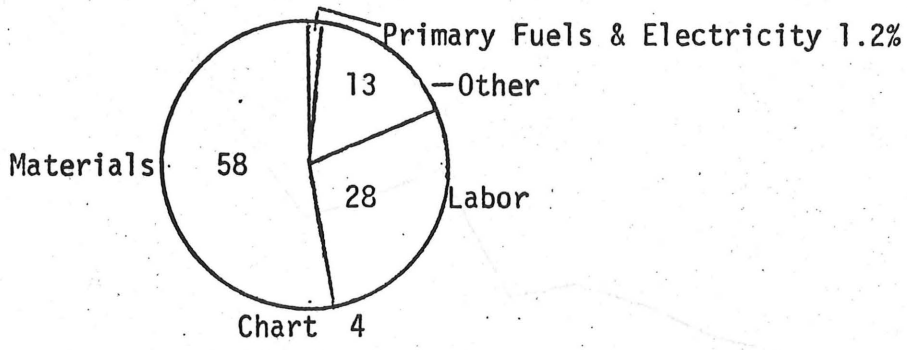


Chart 4

MINN. ENERGY USE- INDUSTRIAL BY FUEL TYPE

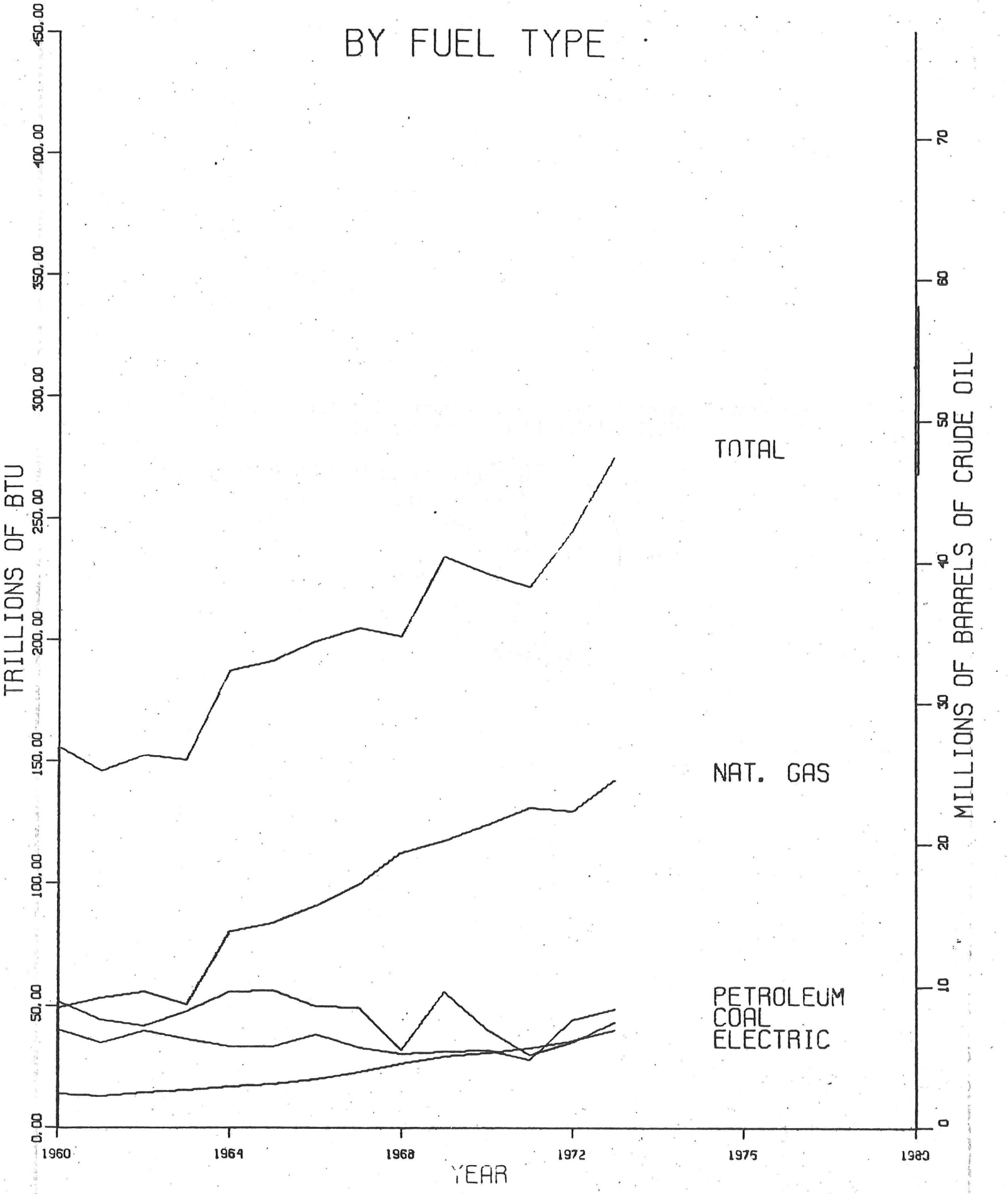


TABLE 2A

Energy Consumption, Employment and Dollar Value Added
Minnesota Manufacturers, 1971

SIC Code	Industry Group	Energy Consumption Trillion BTU	Dollar Value Added (Millions)	Employment (1000s)
20	Food & Kindred Products	31.5	892.5	40.6
26	Paper & Allied Products	28	448.2	17.9
32	Stone,Clay & Glass	10.6	114.9	6.7
33	Primary Metal Industries	8.9	103	6.4
35	Machinery except Electrical	7.2	1015.2	50.7
	Subtotal	92.2	2573.6	122.3
	All Other Manufacturing	22.8	2138.4	149.4
	TOTAL	115	4712	271.7

TABLE 2B

SIC Code	Industry Group	Energy Consumption	Dollar Value Added	Employment
		%	%	%
20	Food & Kindred Products	33	18.9	15
26	Paper & Allied Products	24	9.5	6.6
32	Stone,Clay & Glass	9	2.4	2.5
33	Primary Metal Industries	8	2.1	2.4
35	Machinery except Electrical	6	21.5	18.7
	Subtotal	80	54.4	45.2
	All Other Manufacturing	20	45.6	54.8
	TOTAL	100	100	100

A 5% reduction in fuel intensity in these 5 major energy consuming industries in Minnesota would save sufficient energy for 9000 additional jobs in these industries (Figure 3).

MINNESOTA MANUFACTURING INDUSTRIES BY ENERGY INTENSITY AND EMPLOYMENT

SIC Code	Industry Group	Thousand BTU / $ Value Added
33	Instruments, etc.	5.3
23	Apparel, textiles	6.1
27	Printing, publishing	6.1
36	Electrical equipment	6.3
35	Machinery except electrical	7.1
37	Transportation equip.	7.4
34	Fabricated metals	13.6
28	Chemicals, etc.	13.8
30	Rubber, plastics	16.2
24	Lumber, wood	23.0
22	Textile mill products	33.0
20	Food and kindred products	42.0
39	Miscellaneous mfg.	45.8
26	Paper and allied products	62.5
33	Primary metals	86.4
32	Stone, clay, glass	92.3

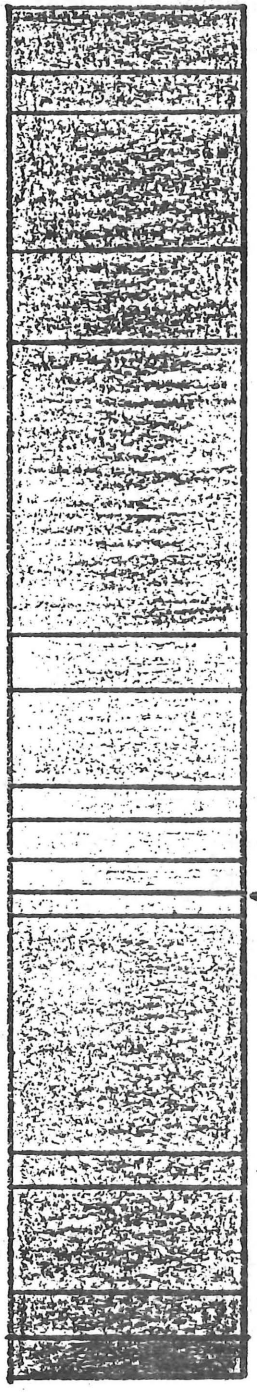


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TABLE 3

Estimated Fuel Savings in 1974 for Minnesota by a 5% Reduction in Fuel Intensity for the Five Major Manufacturing Groups

Major Fuel Types	1974 Energy Use (Trillions of BTU's)	Savings MEA Industries (Trillions BTU)
Coal	13.1	.51
Natural Gas	73.	3.
Fuel Oil	20.3	.49
Electricity	22.2	.67
Total Fuels	128.6	4.67
Additional Workers		9000

TABLE 4

Estimated Employment, Value-Added, and Forecast Fuel Requirements: Minnesota Manufacturers[5]

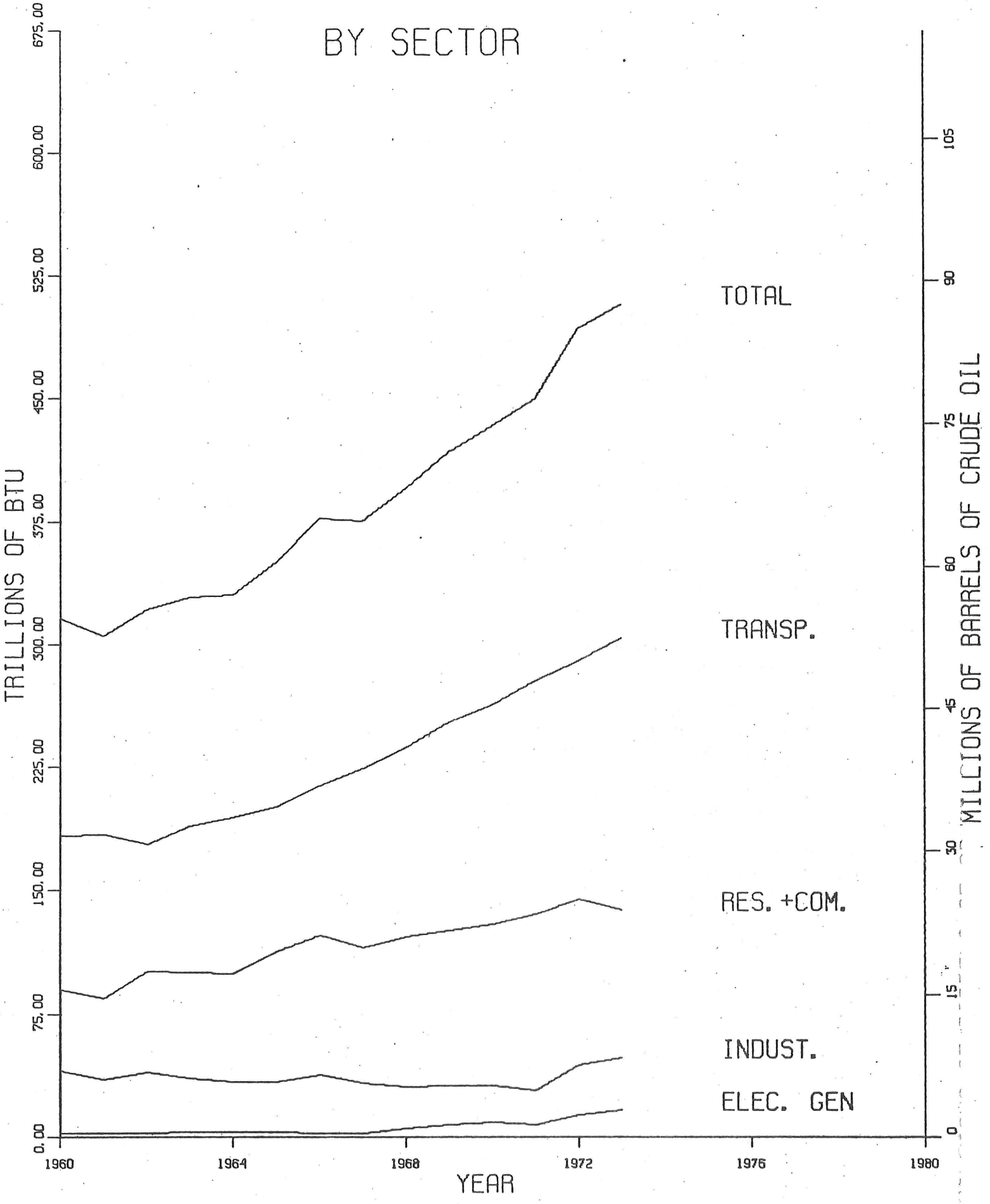
	1971 Actual Energy Use	1974 Estimated Energy Use	1975 Projected Energy Use		1980 Projected Energy Use	
			with Conservation Program	w/o Conservation Program	with Conservation Program	w/o Conservation Program
Employment (1000's)	277.5	300.	338.5	338.5	399.3	399.3
Value-Added (Billion 1967 $'s)	4.2	5.2	5.7	5.7	7.1	7.1
Total Fuels Required	109.	131.	129.5	140.2	148.3	167.
Coal	11.8	13.1	13.1	14.2	13.8	16.
Natural Gas	60.	73.	71.	78.	83.	94.
Fuel Oil	17.2	20.3	20.3	21.4	22.4	24.7
Electricity	17.5	22.2	22.7	24.2	26.7	29.9
Other Fuels	2.4	2.4	2.4	2.4	2.4	2.4

TABLE 5

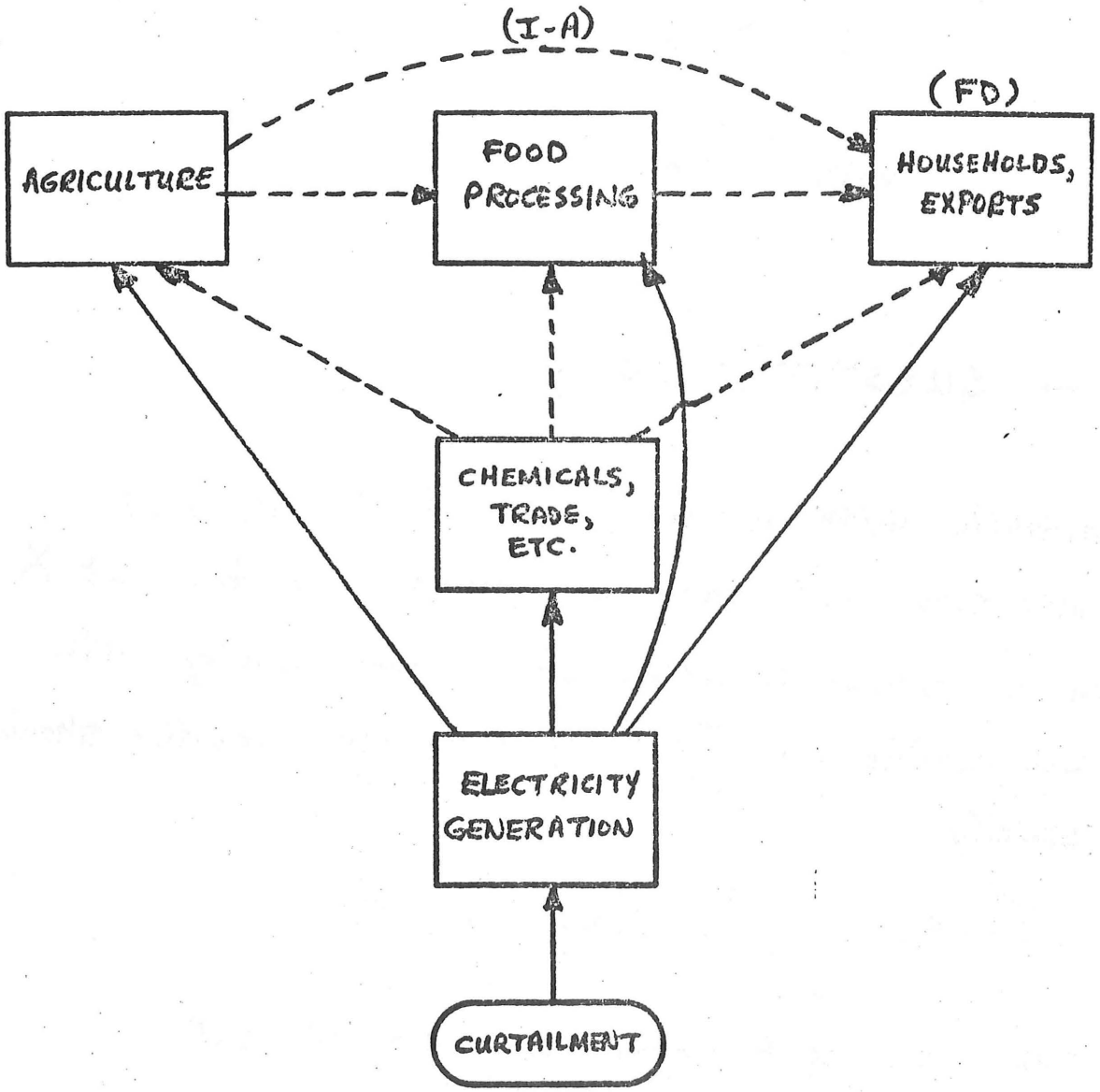
Number of 1000 Megawatt Power Plants Required for the Manufacturing Sector in Minnesota Under Assumed 80% Load Factor 1980

	Alternative Supply Projections	Electric Power Requirements Trillion BTU's	Additional Power Plants	Total Power Plants
I	Historic (continued growth in natural gas and oil supplies)			
	A. No conservation	29.9	.32	1.25
	B. Conservation	26.7	.19	1.12
II	Natural Gas Supply Limited (No growth in supply of natural gas to manufacturers; substitution of oil and electricity equally for gas) Conservation	31.7	.40	1.33
III	Natural Gas and Oil Limited (All growth from electricity) Conservation	38.8	.69	1.62

MINNESOTA USE OF PETROLEUM BY SECTOR



DIRECT AND INDIRECT EFFECTS OF NATURAL GAS CURTAILMENT TO ELECTRICITY GENERATION



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EMPLOYMENT - OPTIMAL ALLOCATION OF FUEL SUPPLIES

$$[I-A]X \leq B$$

$$B \leq FD$$

$$EX \leq F$$

$$X \geq 0$$

$$\text{MAX} \quad LX$$

- SUBSTITUTION -

An activity with a different fuel mix and fuel intensity $x_{e'}$ may be included in the set X through a column insertion of a new activity with technical coefficients $[I-A_{e'}]$. A new row condition should also specify

$$[I-A]x_e + [I-A]x_{e'} \leq B_e$$

So that an augmented constrained set

$$E_{e'} X_{e'} \leq F$$

$$X_{e'} \geq 0$$

includes the new activity and, again,

$$\text{MAX} \quad L_{e'} X_{e'}$$

Table 2. Employment optimal allocation of natural gas supplies after an immediate 5% curtailment.

Industry group	1972 base			CASE A 5% natural gas curtailment		
	Employment	Natural gas	Electricity	Employment	Natural gas	Electricity
	-1,000 workers-	-Bcf-	-m kwhrs-	-1,000 workers-	-Bcf-	-m kwhrs-
Agriculture	187.3	0.0	396.9	187.3	0.0	396.9
Mining	13.6	38.9	2,179.0	13.6	38.9	2,179.0
Construction	63.9	0.6	69.1	63.9	0.6	69.1
Manufacturing						
Food processing	45.9	18.2	1,057.5	45.9	18.2	1,057.5
Other mfg.	253.8	52.6	5,448.3	253.8	52.6	5,448.3
Transportation, Comm.	81.3	8.2	449.9	81.3	8.2	449.9
Utilities*	12.5	54.7	189.5	11.2	43.4	188.8
Trade, Finance, Services	798.9	63.1	6,443.1	797.6	62.7	6,430.2
Total Industry	1,457.2	236.3	16,233.3	1,454.6	224.6	16,219.6
Residential, government, etc.	145.3	107.6	6,803.7	---	---	(1,910.5)
Total State	1,602.5	343.9	23,037.0	---	---	(18,130.1)
*Electric utilities	6.1	51.9	0	4.8	40.6	0
Other utilities	6.4	2.8	189.5	6.4	2.8	188.8

(Contd) Employment optimal allocation of natural gas supplies after an immediate 5% curtailment.

Table 2.

Industry group	Case B[2] Employment	Case B[2] Natural Gas	Case B[2] Electricity	Case C[3] Employment	Case C[3] Natural Gas	Case C[3] Electricity
	-1000 workers-	-Bcf-	-m kwhrs-	-1,000 workers-	-Bcf-	-m kwhrs-
Agriculture	187.1	0.0	396.1	187.3	0.0	396.9
Mining	1.5	0.6	47.1	10.3	27.8	1,562.5
Construction	63.4	0.6	68.5	63.8	0.6	69.1
Manufacturing						
Food processing	45.8	18.2	1,056.0	45.9	18.2	1,057.5
Other mfg.	237.3	35.7	4,073.3	253.6	52.5	5,439.9
Transportation, Comm.	77.5	7.8	427.6	80.7	8.2	446.4
Utilities*	12.1	52.8	185.9	12.5	54.3	189.0
Trade, Finance, Services	793.2	62.7	6,407.5	798.2	63.1	6,437.6
Total Industry	1,417.9	178.4	12,662.0	1,452.3	224.7	15,598.9
Residential, government, etc.	---	---	---	---	---	---
Total State	(-39.3)			(-4.9)		

2/ Reduction in natural gas available for electric generation translated to proportional decline in electric power delivered to industry.

3/ Electric utilities exempted from natural gas curtailment.

*Electric utilities	5.9	50.0	0	6.1	51.5	0
Other utilities	6.2	2.8	185.9	6.4	2.8	189.0