MINNESOTA'S ENERGY SITUATION

A BIENNIAL REPORT TO THE GOVERNOR AND THE LEGISLATURE

MINNESOTA ENERGY AGENCY

JANUARY 1976

The 68th Legislature established the Minnesota Energy Agency in recognition that the energy crisis is real, that it demands the continuing attention of state government.

Since then, the need for the Agency has become more crucial. The cutback in the supply of Canadian crude oil to our refineries, the shortage of natural gas, severe increases in the price of energy, and the lack of a meaningful federal energy policy mean that even more careful management of our limited supplies is required.

Minnesota state government cannot directly affect energy prices, distribution or availability. But the state can take action to manage the energy resources that we use every day, both in the public and private sectors.

Governor Wendell R. Anderson
Special Message to the Legislature
February 18, 1975

The Legislature finds and declares that the present rapid growth in demand for energy is in part due to unnecessary energy use; that a continuation of this trend will result in serious depletion of finite quantities of fuels, land and water resources, and threats to the state's environmental quality; that the state must incure consideration of urban expansion, transit systems, economic development, energy conservation and environmental protection in planning for large energy conservation measures; and that energy planning, protection of environmental values, development of Minnesota energy sources, and conservation of energy require expanded authority and technical capability and a unified, coordinated response within state government.

The Legislature seeks to encourage thrift in the use of energy, and to maximize use of energy-efficient systems, thereby reducing the rate of growth of energy consumption, prudently conserving energy resources, and assuring statewide environmental protection consistent with an adequate reliable supply of energy.

The Minnesota Legislature
Minnesota Statutes 116H.01
1974 Session

FOREWORD

The act creating the Minnesota Energy Agency instructs its director on January 1, 1976, and every two years thereafter to transmit to the Governor and the Legislature a comprehensive report on the energy position of the state.

This is the first of these biennial reports.

The report is organized into three parts. The first part describes Minnesota's energy situation through 1985 including a discussion of major energy sources and conservation alternatives. The second part describes the programs of the agency. The third part contains a number of appendices that respond to additional statutory requirements.

A number of persons merit special appreciation for the development of the energy agency. The Legislature has shown a commitment that is reflected in passage of some of the most progressive energy legislation approved by any state. Governor Wendell R. Anderson showed leadership in the energy field when leadership was needed. The Legislative Commission on Energy (1974-75) charted an enlightened direction for the agency. John C. McKay, the agency's initial director, assembled an excellent and dedicated staff.

The report provides a time of reckoning. Its final review has left me with some ambivalence. There is much we know and are doing about Minnesota's energy position. Yet there is far more to do.

John P. Millhone
Director
Minnesota Energy Agency

CONTENTS

I. SUMMARY OF RECOMMENDATIONS

Crude Oil. The State of Minnesota receives nearly 25 percent of its total energy supply from crude oil imported from Canada. The rapid curtailment of Canadian exports is the most serious energy problem facing the state. To avoid disastrous economic and social consequences, it is imperative that the state move vigorously to secure the largest possible portion of the remaining Canadian exports and in concert with the Minnesota-area refineries initiate an aggressive plan to secure alternative sources of crude oil.

Natural Gas. The continuing decline of natural gas supplies in Minnesota is the second most serious energy supply problem facing the state. To alleviate the impact, the state needs to identify curtailed areas and provide reliable information on alternative energy supplies, work in concert with gas pipelines, distribution utilities and users to help develop a curtailment schedule that minimizes adverse impacts, and seek aggressively to increase gas supplies available in Minnesota, particularly through the support of the trans-Canadian gas pipeline from Alaska.

Coal. Minnesota's most promising, quickly developable energy resource is coal. The state's closeness to the Northern Great Plains' huge coal deposits means coal use here will increase rapidly. The Energy Agency projects a tripling of coal use in the next 10 years, an estimate which is lower than some

projections. To prepare for this increase, it is essential the state develop a coal use and development plan that considers the full range of coal fuel cycle issues -- boom town-bust town, land reclamation, transportation, transshipment, air quality and research. This calls for a multi-agency effort for public and private cooperation and for close communication between Minnesota and the Western coal-producing states.

Alternative Sources. As traditional energy sources are depleted, it is essential to have new supplies available. If these sources are to be available at the high volumes required, a strong stimulus to their development must be provided immediately. The development of a state peat policy already is underway with the Department of Natural Resources serving as the lead agency. The state's long heating season makes a solar energy use and development plan deserve vigorous support. Solid waste, biomass and wind are other promising alternative energy resources.

Electricity. The use of electricity has increased more rapidly than the use of primary energy resources. The projections of the electric industry, subject to Certificate of Need approval, continue this trend. The development of the industry has been subject to piecemeal, time-consuming governmental processes which are unsatisfactory for a number of reasons. The long lead times required increase the difficulty of determing future demand. The process saps the resources of the utilities and of those who question the utilities' plan. Basic questions concerning state and regional fuel energy needs are rarely

confronted while lesser issues are argued interminably. The agency intends to explore ways to improve the efficiency of the process used to approve energy facilities.

Conservation. The State of Minnesota already has led the nation in developing some specific conservation programs. The conservation plan in this report is the first effort at a comprehensive plan that coordinates energy use with energy-saving measures and specific conservation objectives. The new national Energy Policy and Conservation Act provides an additional stimulus to improve and consolidate these conservation activities. A strong and growing conservation program is essential for any state, but particularly for Minnesota with virtually no developed energy resources of its own and with a variety of serious energy supply problems.

II. MINNESOTA'S ENERGY SITUATION TO 1985

In March of 1975, the Minnesota Energy Agency made a presentation to the now-defunct Legislative Commission on Energy outlining Minnesota's energy supply and demand situation over the next ten years. The information presented was later published in a short report entitled Minnesota's Energy Situation to 1985. This section is an update of that report, including new estimates which have since been developed by the Energy Agency using data from various sources.

The supply and demand estimates are the best now available to the Minnesota Energy Agency based on its studies of historical trends, current changes in energy supply and use patterns, and the actions and plans of major energy producers, distributors and users. These estimates are constantly being refined as new information becomes available and are thus subject to change. Nevertheless, we believe this summary provides a meaningful outline of Minnesota's energy situation and the actions needed to cope with it.

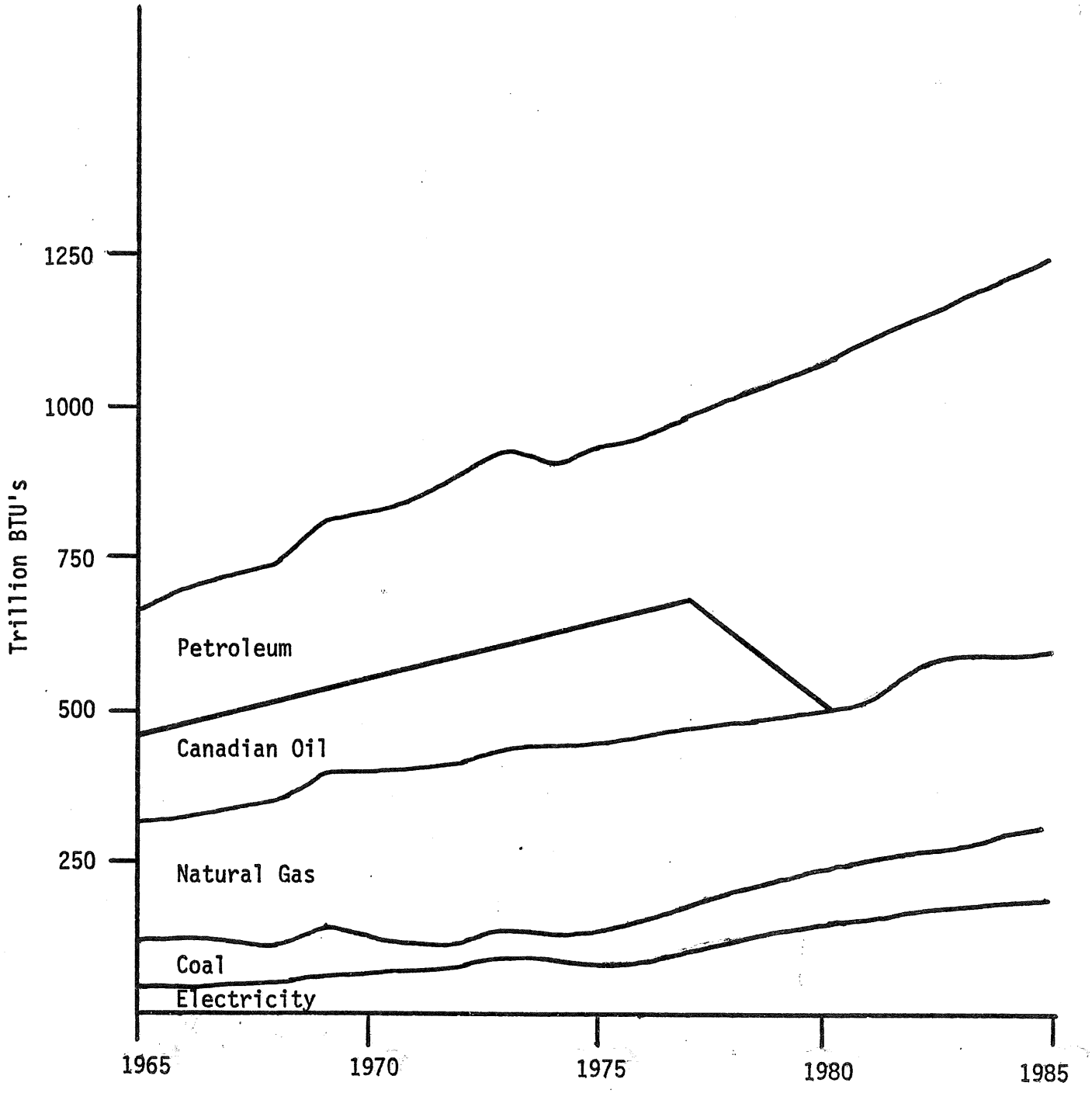
Supply

The conventional energy supplies available to Minnesota are projected to increase 47.1 percent from 1105 trillion BTU's in 1975 to 1626 trillion BTU's in 1985. Supply estimates were obtained from the major producers, distributors, or users of each form of energy.

Coal is projected to be the major growth fuel for Minnesota in the next decade. The supply of coal to the state--largely

MINNESOTA PRIMARY ENERGY SUPPLY

BY FUEL TYPE



MINNESOTA PRIMARY ENERGY SUPPLY

BY FUEL TYPE

	Petroleum		Natural Gas		Coal		Hydro & Nuclear		Total	
YEAR	BTU	PCT	BTU	PCT	BTU	PCT	BTU	PCT	BTU	PCT
1965	350.2	45.6	248.8	32.4	157.2	20.5	11.6	1.5	767.8	100.0
1966	377.1	46.2	264.4	32.4	163.1	20.0	12.3	1.5	816.9	100.0
1967	375.3	45.8	283.1	34.6	151.6	18.5	9.3	1.1	819.3	100.0
1968	395.6	45.5	309.2	35.5	155.7	17.9	9.3	1.1	869.8	100.0
1969	418.0	45.3	322.7	35.0	172.0	18.7	9.1	1.0	921.8	100.0
1970	433.8	45.1	334.9	34.8	186.1	19.3	8.0	.8	962.8	100.0
1971	449.7	45.3	343.6	34.6	176.4	17.8	22.2	2.2	991.9	100.0
1972	492.9	46.1	344.0	32.2	183.4	17.2	48.6	4.5	1068.9	100.0
1973	507.9	46.0	355.5	32.2	194.5	17.6	45.6	4.1	1103.5	100.0
1974	466.7	43.5	348.0	32.4	205.3	19.1	53.5	5.0	1073.5	100.0
1975	485.	43.9	326.	29.5	183.	16.6	111.	10.0	1105.	100.0
1976	501.	43.6	303.	26.4	232.	20.2	113.	9.8	1149.	100.0
1977	516.	43.0	290.	24.1	280.	23.3	115.	9.6	1201.	100.0
1978	543.	43.3	278.	22.2	315.	25.1	118.	9.4	1254.	100.0
1979	560.	42.7	266.	20.3	364.	27.8	120.	9.2	1310.	100.0
1980	574.	41.7	265.	19.3	413.	30.0	123.	8.9	1375.	100.0
1981	574.	40.3	288.	20.2	438.	30.8	123.	8.6	1423.	100.0
1982	577.	39.3	312.	21.2	457.	31.1	123.	8.4	1469.	100.0
1983	610.	40.1	301.	19.8	488.	32.1	123.	8.1	1522.	100.0
1984	640.	40.7	291.	18.5	518.	33.0	123.	7.8	1572.	100.0
1985	669.	41.1	281.	17.3	553.	34.0	123.	7.6	1626.	100.0

"BTU" = Trillions of BTU

low-sulfur Western coal brought in by rail--is expected to triple in the next ten years if presently planned coal-fired electricity generation plants are approved for construction. Coal supplied for conventional purposes (i.e., excluding gasification or liquefaction) is projected to increase from about 8.6 million tons in 1975 to 28 million tons in 1985, and its share of Minnesota's total energy supply will grow from 17 percent in 1975 to 34 percent in 1985.

Much of this growth will occur as a result of declining supplies of natural gas. Natural gas supplied to Minnesota is expected to decline from 348 billion cubic feet in 1974 to 265 billion cubic feet in 1980. The proposed completion of a pipeline bringing Alaskan gas across Canada into the Midwest by mid-1981 would briefly stem this decline, but by 1985 natural gas supply still would be only 281 billion cubic feet. The share of Minnesota's primary energy supplied by natural gas is expected to drop from 30 percent in 1975 to 17 percent by 1985.

Nuclear generation of electricity in Minnesota has grown dramatically with the completion of Northern States Power Co.'s Monticello and Prairie Island plants and now approaches 10 billion kilowatt hours annually. With increasing plant reliability and load factors, this is projected to reach 11 billion kilowatt hours by 1985. Hydroelectric generation is expected to remain essentially constant at 0.7 billion kilowatt hours between now and 1985. No new nuclear or hydroelectric generating plants have been announced for Minnesota during this

time, and the share of the state's total primary energy derived from these sources is expected to decline from an estimated 10 percent in 1975 (up from five percent in 1974) to less than 8 percent by 1985.

Minnesota also imports electricity from other states and from Canada. These imports are difficult to determine and even more difficult to project because of the complex daily and seasonal transfers back and forth among utilities. In 1974, an estimated 4.9 billion kilowatt-hours, or 19 percent of Minnesota's electricity, came from net imports.

The remaining major primary fuel, petroleum, provided 44 percent of Minnesota's primary energy supplies in 1975. Petroleum is projected to maintain its dominance in the next ten years, although declining slightly to 41 percent in 1985. This assumes that answers will be found to the crucial problem Minnesota faces of getting 5 billion gallons of petroleum to the state in 1975, an increase from the 4 billion gallons used in 1975. The Canadian National Energy Board has announced an accelerated schedule for phasing out crude oil exports between now and 1981. Federal Energy Administration allocation rules now being considered could delay the impact of this phase-out on Minnesota-area refineries, but even so a new source of crude oil must be found quickly--and a way of transporting it to Minnesota.

Demand

Minnesota's energy demand is expected to grow by nearly 50 percent in the next 10 years, paralleling the supply increase.

Total demand will be restrained somewhat by conservation measures, whether taken in response to voluntary actions, governmental policy or economic incentives and pressures. However, no major new conservation measures are assumed in these demand forecasts. The share of net energy demand accounted for by each of the major end-use sectors will remain fairly stable, with residential and commercial users making up about 38 percent, transportation about 30 percent, and industry about 32 percent by 1985.

Looking at gross or primary energy use, however, the projections anticipate a striking shift toward electricity generation as users obtain more of their energy in the form of electricity in place of dwindling natural gas supplies. In 1985, the projections show 36 percent of Minnesota's primary energy being used to generate electricity, compared with 25 percent in 1975. This increase would be met by a tripling of the coal used to generate electricity as petroleum and natural gas are diverted to other sectors.

In the residential and commercial sector, natural gas is expected to remain the dominant fuel, providing nearly half (49 percent) of total net energy used by this sector in 1985. Heating oil, LP-gas, and other petroleum products would continue to provide about one third (31 percent) of residential and commercial energy in 1985. Electricity is projected to grow from its present 13 percent to about 19 percent of the energy used in this sector.

ENERGY USE BY THE THREE

MAJOR CONSUMING SECTORS IN MINNESOTA

	Residential & Commercial		Transportation		Industry		Total	
YEAR	BTU	PCT	BTU	PCT	BTU	PCT	BTU	PCT
1965	267.6	40.5	200.7	30.4	191.8	29.1	660.1	100.0
1966	287.8	41.1	213.7	30.5	199.5	28.5	701.0	100.0
1967	288.2	40.2	224.3	31.3	205.0	28.6	717.5	100.0
1968	303.8	40.9	237.3	31.9	201.7	27.2	742.8	100.0
1969	321.3	39.7	252.9	31.3	234.4	29.0	808.6	100.0
1970	335.1	40.6	263.1	31.9	227.4	27.5	825.6	100.0
1971	340.3	40.5	278.4	33.1	221.8	26.4	840.5	100.0
1972	356.4	40.0	290.6	32.6	245.1	27.5	892.1	100.0
1973	344.8	37.3	304.4	32.9	275.8	29.8	925.0	100.0
1974	352.2	39.5	286.2	32.1	253.9	28.5	892.3	100.0
1975	360.	39.2	292.	31.8	267.	29.1	919.	100.0
1976	369.	39.2	298.	31.6	275.	29.2	942.	100.0
1977	379.	38.8	306.	31.4	291.	29.8	976.	100.0
1978	389.	38.5	313.	31.0	308.	30.5	1010.	100.0
1979	399.	38.6	319.	30.9	315.	30.5	1033.	100.0
1980	412.	38.6	326.	30.6	329.	30.8	1067.	100.0
1981	423.	38.3	334.	30.3	346.	31.4	1103.	100.0
1982	435.	38.4	340.	30.0	359.	31.7	1134.	100.0
1983	448.	38.3	349.	29.8	373.	31.9	1170.	100.0
1984	460.	38.3	356.	29.6	385.	32.1	1201.	100.0
1985	473.	38.2	365.	29.5	400.	32.3	1238.	100.0

"BTU" = Trillions of BTU

The shift toward electricity is even more marked in the industrial sector, where more than 25 percent of the total net energy demand is expected to be met by electricity in 1985, as opposed to only 15 percent in 1975. Similar growth is expected to occur in industrial use of petroleum (20 to 33 percent) and coal (18 to 30 percent) as natural gas supplies decrease and are reserved increasingly for the residential market. Natural gas, which met 54 percent of industry's energy needs in 1974 is expected to drop to only 12 percent by 1985. (The above estimates of the impact of natural gas curtailments on other fuels is derived from a survey by the Energy Agency of major natural gas users.)

The transportation sector, of course, will continue to rely almost exclusively on petroleum products unless there is a significant breakthrough to electrically powered vehicles, methane or some other alternate fuel. Transportation's share of total petroleum use is expected to remain high at 57 percent.

Forecast Assumptions

The growth rates for residential and commercial sector primary fuel use were determined by first averaging recent historic growth rates with those generated by the Energy Agency's residential and commercial energy use projection models, as shown below:

	ANNUAL GROWTH RATE		
	Petroleum	Natural Gas	Coal
Historic Growth (1968-1972)	3.42%	4.18%	-18.3%
Model Projections (1974-1985)	0.19%	1.37%	0.0%
Average	1.8%	2.8%	-9.0%

The petroleum growth rate was then adjusted downward to account for shifts to electricity. Of the total projected shift from petroleum to electricity, 20 percent was estimated to be in the residential and commercial sector. The resulting adjusted growth rate for residential and commercial petroleum demand was 1.2 percent per year. Residential and commercial electricity consumption projections were taken from Certificate of Need applications submitted by Northern States Power Co., Minnesota Power and Light Co., Cooperative Power Association, and United Power Association.

Projections of industrial primary fuel use to 1985 were derived by a two-step process. First, each industry's projected output (from the MINTOM econometric model) was multiplied by its 1974 energy intensity and the results used to obtain a composite growth rate for all Minnesota industries. This growth rate (3.9 percent) was applied to total 1974 industrial primary fuel consumption and the yearly increases were added half to coal and half to petroleum. In the second step, expected natural gas curtailments to 1978 were replaced by the alternate fuels indicated by users in the Energy Agency's natural gas survey, and curtailments after 1978 were allocated 20 percent to coal and 80 percent to petroleum.

Industrial electricity use projections were based on utility forecasts and included increases due to fuel shifts only in the case of Northern States Power Co. Of the total shift from petroleum to electricity projected by NSP, 80 percent was subtracted from industrial petroleum and 20 percent from residential and commercial sector petroleum use.

Growth rates used for fuel consumption in the transportation sector are an average of those generated by the Energy Agency's MINTOM econometric model and those derived from its transportation sector projection model. Estimated annual growth rates for 1975-1985 were: private auto - 1.6 percent, light trucks - 3.8 percent, heavy trucks - 2.5 percent, railroad - 3.2 percent, aviation - 4.6 percent, and others - 4.1 percent. The composite growth rate of the transportation sector based on a weighted average of these growth rates is 2.3 percent per year.

Projected electricity production was taken from long range forecasts submitted to the Energy Agency by the utilities. Total production was broken down into the various primary fuels used on the basis of company estimates and the results of the Energy Agency's electricity generating projection model. The natural gas projections show the expected complete curtailment of this sector by September 1976. The uneven growth of petroleum is a result of discrete plant changes. Coal use was projected by subtracting petroleum, natural gas, hydro, and nuclear projections from total production.

In the next section, a detailed examination will be made of each energy source. These include both the traditional supplies of petroleum, natural gas, propane, coal, and electricity and such alternative sources as peat, solar energy,

FUELS USED FOR ELECTRICITY

GENERATION IN MINNESOTA

	Petroleum		Natural Gas		Coal		Hydro & Nuclear		Total	
YEAR	BTU	PCT	BTU	PCT	BTU	PCT	BTU	PCT	BTU	PCT
1965	2.7	1.8	51.3	33.9	85.8	56.7	11.6	7.7	151.4	100.0
1966	2.1	1.3	51.2	31.3	98.2	60.0	12.3	7.5	163.8	100.0
1967	2.4	1.5	55.5	35.8	87.8	56.6	9.3	6.0	155.0	100.0
1968	5.1	2.7	64.7	34.8	106.7	57.4	9.3	5.0	185.8	100.0
1969	7.1	4.0	64.1	36.1	97.5	54.8	9.1	5.1	177.8	100.0
1970	8.8	4.3	58.6	28.4	131.2	63.5	8.0	3.9	206.6	100.0
1971	7.6	3.4	59.1	26.3	135.9	60.5	22.2	9.9	224.8	100.0
1972	13.2	5.2	51.9	20.3	141.7	55.5	48.6	19.0	255.4	100.0
1973	16.5	6.2	56.7	21.4	145.7	55.1	45.6	17.2	264.5	100.0
1974	8.9	3.4	38.5	14.5	164.1	61.9	53.5	20.2	265.0	100.0
1975	9.	3.3	23.	8.5	129.	47.4	111.	40.8	272.	100.0
1976	11.	3.7	0	0	171.	58.0	113.	38.3	295.	100.0
1977	10.	3.0	0	0	209.	62.6	115.	34.4	334.	100.0
1978	16.	4.3	0	0	236.	63.8	118.	31.9	370.	100.0
1979	13.	3.2	0	0	277.	67.6	120.	29.3	410.	100.0
1980	11.	2.4	0	0	320.	70.5	123.	27.1	454.	100.0
1981	10.	2.1	0	0	343.	72.1	123.	25.8	476.	100.0
1982	15.	3.0	0	0	362.	72.4	123.	24.6	500.	100.0
1983	18.	3.4	0	0	384.	73.1	123.	23.4	525.	100.0
1984	22.	4.0	0	0	406.	73.7	123.	22.3	551.	100.0
1985	23.	4.0	0	0	432.	74.7	123.	21.3	578.	100.0

"BTU" = Trillions of BTU

wind, agricultural and forest residues, urban and animal wastes, and heat from power plants.

PETROLEUM

Petroleum, or crude oil, is the largest source of energy used in Minnesota, providing an estimated 44 per cent of the state's energy needs in 1975.

In its natural state, crude oil is a black, viscous liquid found underground in porous rocks. A mixture of gaseous, liquid and solid hydrocarbons, it is the residue of the organic tissue of marine plants and animals that lived on earth hundreds of millions of years ago.

Oil is drawn from the ground in oil fields, then carried by collector pipelines to refineries where it is distilled into products ranging from gases to heavy asphalts. Major products of the refining process are gasoline and fuel oils.

Minnesota has no oil resources of its own. Petroleum enters the state primarily through crude oil and product pipelines, although small amounts enter by barge, railroad tank car and truck.

About 58 percent of the petroleum products used in Minnesota come from four Minnesota-area refineries. The other 42 percent enters the state through product pipelines.

Petroleum Uses

In the refinery process, the constituents of crude oil are separated according to their boiling points after undergoing a series of chemical processes. The approximate fractions obtained from the Minnesota-area refineries are:

Refinery Fraction	Boiling Point Range	Approximate Production
Refinery gases (ethane, propane, butane)	less than 200°F	4 %
Motor gasoline	140°F - 690°F	50 %
Middle distillates #1 & # 2 fuel oil diesel fuel jet fuel	371°F - 700°F	25 %
Residuals #4,5,6 fuel oil bunkering oil	50 percent boiling point greater than 700°F	12 %
Asphalts and road oils		9 %
		100 %

Refinery gases are used as a petrochemical feedstock or as liquefied petroleum gas (LPG). LPG is used primarily as a replacement for natural gas in some industrial applications, for heating and cooking by rural residential customers, and for grain drying and other agricultural uses.

Gasoline is used almost exclusively as a transportation fuel.

The middle distillates (kerosene, number 1 and 2 fuel oils) are used for space heating, as a boiler fuel in industrial processes, and in transportation. Diesel fuel and number 2 heating oil are the same petroleum product except for the use of certain additives in diesel fuel.

The residuals, or heavier fuel oils, are used as a boiler fuel for large industrial and commercial firms, schools and hospitals. They are very viscous and cannot be transported by pipeline. While some residual product is shipped into Minnesota by barge, most residual oil used here comes dir-

ectly from the Minnesota-area refineries.

Asphalt, a heavy product similar to residual oil, is used for road-building purposes.

All petroleum products can be transported and stored. Motor gasoline and middle distillates can be transported by pipeline, so access to a local refinery does not greatly influence final product costs. Transportation costs for the heavier fractions -- residuals and asphalts -- are greater if there is no local refinery.

Refineries

The construction of oil refineries in Minnesota had its origin in the recognition by Americans and Canadians that they had more to gain than lose through cooperation in the energy field, a lesson worth remembering.

Crude oil was discovered in the Province of Alberta in 1947. The amount available was greater than the demand in Canada's prairie provinces and there was no financial incentive to pipe oil to Eastern Canada when inexpensive imported oil was available there. The need for petroleum products was growing in the Upper Midwest. The Minnesota-area refineries were constructed to provide an outlet for the new Canadian discoveries and to meet this growing U.S. demand.

The Interprovincial-Lakehead Pipeline system was constructed in 1950 from Edmonton, Alberta, to Superior, Wisconsin with an extension to the St. Paul area to supply Canadian crude oil to the Minnesota-area refineries.

About 70 percent of the output from these four refineries is used in Minnesota. The remainder is supplied to neighboring areas of western Wisconsin, northern Iowa and eastern North and South Dakota.

The four Minnesota-area refineries,[1] their locations, and capacities are:

Owner	Location	Capacity (barrels per day)
Koch Refining Co.	Pine Bend (near St. Paul)	109,800
Ashland's Northwestern Refining Co.	St. Paul Park	66,000
Continental Oil Co.	Wrenshall (near Duluth)	23,500
Murphy Oil Co.	Superior, WI.	45,000
	TOTAL	244,300

Although they have a combined capacity of nearly 250,000 barrels per day, they have operated only at about 200,000 in 1974 and 1975. Refineries do not expect to operate at 100 percent of capacity, but this is well below their expectations.

1. As used here, the Minnesota-area refineries include the Murphy Oil Co. refinery in Superior, Wisconsin across the state line from Duluth, Minnesota. The Murphy refinery exports 40 percent of its products into Minnesota and has a major role in the state's supply situation.

Product Pipelines

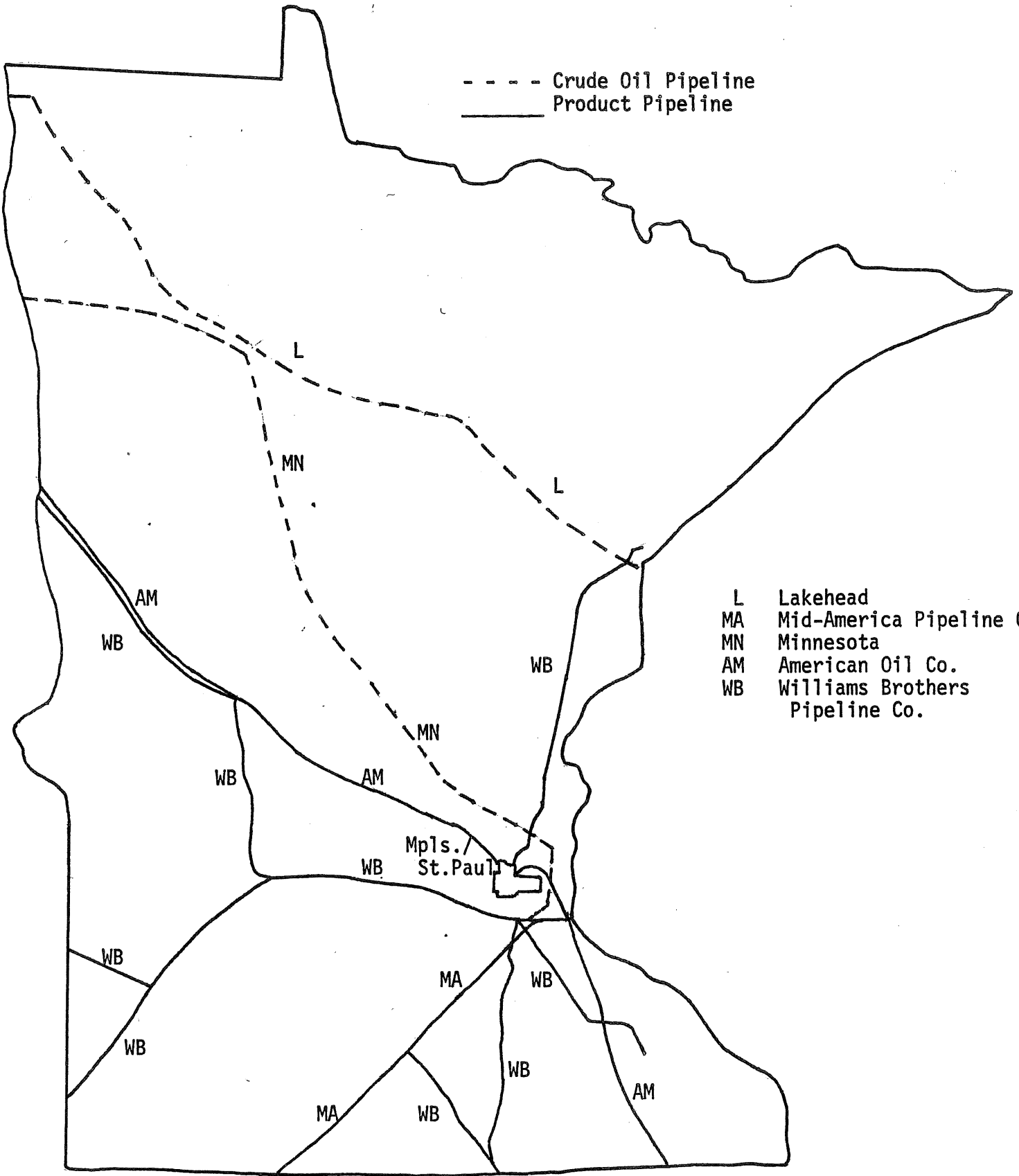
Petroleum products not refined locally enter Minnesota through product pipelines connecting out-of-state refineries to Minnesota distributors. The state is served by two pipeline systems, the William Brothers Pipeline Co. and an Amoco Oil Co. pipeline.

The Williams Brothers system is a common carrier that moves petroleum products for a fee, much like a common carrier truck line. The Williams system includes a major capacity pipeline connecting St. Paul with Tulsa, Oklahoma, and smaller pipelines extending northeast from St. Paul to Duluth-Superior, northwest from St. Paul to Grand Forks, North Dakota, and from Sioux City, Iowa, into Western Minnesota.

The Amoco pipeline is not a common carrier, but is owned by Amoco and is used to bring gasoline and fuel oil from that company's refinery in Mandan, North Dakota, to west central Minnesota and from Amoco's Wood River refinery near Chicago to the Twin Cities area. The two pipeline sections meet at the Amoco terminal in Sauk Centre, Minnesota.

In recent years, these product pipelines have brought an average of about 100,000 B/D of fuel oil and gasoline into Minnesota or about 42 percent of the state's petroleum supplies. Volumes have varied considerably, rising close to their capacity of 194,000 B/D in the winter because of the heavy demand of fuel oil for space heating.

OIL PIPELINES



Source: American Petroleum Institute

Canadian Crude Curtailments[2]

Because of Minnesota's historical reliance on Canadian crude oil, the rapid curtailment of Canadian oil exports is creating greater problems for Minnesota than for any other state.

Canadian oil exports to the United States have declined rapidly since reaching a peak of 1,100,000 B/D in 1973. The decrease is due not only to curtailments but also to the high prices on crude oil set by the Canadian National Energy Board (NEB).

The NEB in the fall of 1974 set a ceiling on exports of 800,000 B/D in 1975, but the high Canadian price kept actual exports last year to 700,000 B/D. The NEB late last year announced a further cutback to 510,000 B/D during the first months of 1976, with an additional curtailment to 385,000 B/D after the completion of the Sarnia-Montreal pipeline, scheduled for the summer of 1976. In the previous curtailment schedule, exports this year had been set at 560,000 B/D.

All four Minnesota-area refineries are heavily dependent upon Canadian crude oil. The northern refineries at Wrenshall and Superior are totally dependent upon Canadian crude oil. The Ashland refinery obtains about 90 percent of its crude oil from Canada; the Koch refinery about 80

---

[2] This section is based upon testimony by the Minnesota Energy Agency at a December 8, 1975 hearing by the Federal Energy Administration on its proposed Canadian Crude oil allocation plan. For a fuller discussion of this issue, a copy of this testimony is available from the MEA.

percent. Both obtained small amounts of additional crude oil by barge, tank car, and the Portal pipeline from North Dakota. Some crude oil batches were sent to St. Paul in the Williams Brothers product line as well.

If the Canadian-dependent refineries were forced to close, the state would lose nearly one-fourth of its current energy supplies, only a portion of which could be offset by increased shipments through existing product pipelines.

The Canadian oil export cutbacks pose the most serious energy problem confronting Minnesota. In the short-term, Minnesota is seeking a preferential allocation of available Canadian supplies for those refineries which have no alternative source of crude oil and is encouraging the Minnesota-area refineries to explore the possibility of swapping Canadian oil here for U.S. oil supplied to Canada elsewhere.

Even with these efforts, the Minnesota-area refineries have at the most two or three years to obtain alternate sources of crude oil if the Canadian curtailment schedule is maintained. The most promising possibilities are a new pipeline to bring in domestic or imported crude oil from sources south of Minnesota, reversal of Canada's Trans-Mountain pipeline or the construction of a new northwestern U.S. pipeline to bring new Alaskan crude oil from the Puget Sound area.

Marketing

The marketing of petroleum products is undergoing rapid change. In the past, the major oil companies concentrated their

profit making on the production and sale of crude oil. These profits are currently being squeezed by the higher prices charged by oil-producing countries and the emphasis on fuel economy. The major oil companies are adjusting by giving new attention to the profit potential of refinery and market activities.

The independent service station operator is having great difficulty surviving under these changed market conditions. In 1972, there were 226,000 independent retail service stations in the United States. This number declined to an estimated 150,000 by the end of 1975.

In Minnesota, as elsewhere, the major oil companies are tightening up their marketing operations. Minnesota last year lost between 200 and 250 branded independent outlets and independent unbranded outlets. If this trend continues, there will also be fewer small independent jobbers and bulk dealers.

One major oil company already has converted to the concept of super-jobbers who supply smaller, formerly independent jobbers. Two other major companies are in the process of adopting the same concept. Another major company is offering its company-owned bulk storage facilities for sale to the larger jobbers. Some oil companies are selling some of their service stations to these larger jobbers. The net result is a consolidation of petroleum marketing into fewer hands.

In gasoline retailing, the trend is away from the traditional full-service operation to fast service, less service, and self-service operations and to the combining of gasoline marketing with companion operations such as convenience stores, dairy stores, car-care centers, tire stores and car washes.

The administration by the Federal Energy Administration of the Emergency Petroleum Allocation Act has encouraged these changes by the ease with which allocations are given to new retailers while existing service stations have difficulty obtaining increased supplies.[3]

Future Supplies

The supply of petroleum is the greatest area of uncertainty in Minnesota's energy future.
No national decision has been made on where to use Alaskan crude oil once it becomes available in 1978. It may be shipped by tanker to the West Coast and pumped through crude lines to Midwest and Gulf Coast refineries. It may be shipped by supertankers to Central America, pumped through a trans-isthmus pipeline and brought by regular tanker to the East Coast and Gulf ports; it may be shipped through the Panama Canal in small tankers; or it may be shipped around South America's Cape Horn in supertankers.

Despite much rhetoric about energy independence, the national policy apparently is to increase crude oil imports to meet a growing demand. The nation's dependence on OPEC sources has grown from 49 percent of total imports prior to the embargo to 60 percent by early 1975.

---

[3]. For a further discussion of this issue, see testimony presented by the Minnesota Energy Agency on November 20, 1975 in Chicago at an FEA hearing on proposed regulations terminating the state set-aside program. Copies are available from the MEA.

Despite initial concern about the impact of crude oil imports on the balance of payments, the nation spent $24 billion for foreign oil last year and enjoyed the largest positive trade balance in history.

These are national issues, but they directly affect the development of state energy plans. Until a different direction is set, the most plausible assumption appears to be that crude oil will continue to be imported to meet the increasing demand for petroleum products.

The demand is projected to increase in Minnesota from 240,000 B/D in 1975 to 300,000 B/D in 1980 and 340,000 B/D in 1985. Petroleum products will remain the largest source of energy in Minnesota in 1985, but their percentage of state energy supplies will decline slightly from 44 to 41 percent.

NATURAL GAS

Natural gas is the term used for a mixture of naturally occurring gaseous hydrocarbons. The product is obtained in much the same way as petroleum, i.e. through exploration and drilling. The gas that is delivered to homes and businesses is primarily methane, which has a heating value of about 1000 BTU/ft^3. Other products in the naturally appearing mixture (ethane, propane, etc.) are separated from the natural gas near the well for use as petrochemical feedstocks or fuel.

The natural gas industry is characterized by the direct connection that exists between the gas well and the end user. This direct pipeline connection requires very careful control so that pressures and flows are balanced in all parts of the system. In many ways the distribution of natural gas is similar to the distribution of electricity.

Natural gas can be stored in underground formations or as a liquid at cryogenic temperatures, but at the current time gas in storage does not represent a large portion of the total gas supply.

U.S. natural gas reserves have declined in seven of the last eight years. The only exception was 1970 when Alaska's North Slope reserves were first listed.

This chapter examines the problems of the natural gas shortage as it applies to Minnesota. It presents projections of natural gas curtailments in Minnesota's industrial sector from 1974 - 1980, and examines the possible effects of curtailment. The schedule shown in this section is based on model

projections which indicate that gas consumption in the commercial and residential sectors will grow more slowly in the past. The historical rate was 4.2 percent per year from 1966 to 1973. The projected rate is 2.8 percent per year. Curtailment in the industrial sector is expected to proceed rapidly to offset the increase in commercial and residential gas consumption The total curtailment by the Northern Natural Gas Co. over the next five years is projected to be 58 billion cubic feet (BCF) or 19 percent of Minnesota's 1974 gas supply from the pipeline company. These curtailment figures probably will be modified periodically as new supply/demand information becomes available. On December 31, 1975, Northern Natural Gas filed a new curtailment plan with the Federal Power Commission. This plan will substantially modify Minnesota's situation, but the evaluation of its impact is still incomplete.

Structure of Natural Gas Industry

The gas industry consists largely of investor-owned companies whose prices are regulated by Federal agencies. There are three sectors: (1) the exploration and production sector, which consists of major oil companies and independent operators; (2) the transmission sector, which transports the gas to the market and is composed largely of independently owned pipelines; and (3) the distribution sector, made up primarily of local utilities, which retail the gas in limited markets.

Exploration and Production Sector

Northern Natural Gas, which provides 93 percent of Minnesota's natural gas, obtains its gas from fields in Texas, New Mexico, Oklahoma, Kansas, and Montana as follows:[1]

Major Production Areas	State	Percent of Total Gas Supplied to Northern
Permian Area	Texas New Mexico	47
Hugoton-Anadarko Area	Texas Oklahoma Kansas	51
Rocky Mountain Area	Montana	2

Northern Natural purchases its gas under various contracts with different expiration dates and different prices. The average field price paid by Northern was 29 cents per thousand cubic feet (MCF) in September, 1975. This was an 81 percent increase from Northern's average field price of 16 cents in 1971[2].

Since 1954 the Federal Power Commission has had the authority to regulate the prices paid for gas sold in interstate pipelines. However, the FPC does not have jurisdiction over intrastate sales of gas. Prices for gas in most intrastate markets have risen dramatically in the last few years. Producer prices in excess of $1.50 per MCF are not uncommon. It has been increasingly hard for interstate pipelines to purchase new gas because producers can sell in the intrastate market at prices

---

1. Some Montana gas finds its way to Minnesota through trade agreements with the Canadians.

2. Information obtained from Robert Garfoot, Manager of Marketing, Northern Natural Gas Co.

higher than FPC ceilings. Since 1970 an increasing portion of net reserve additions has been marketed in the intrastate markets.

According to Gordon Severa, President of Northern Natural's Transmission Division, more than 80 percent of the new gas in its traditional supply market is going to the intrastate market, as opposed to 30 - 40 percent in previous years.

The remaining seven percent of the natural gas used in Minnesota is imported from Canada at a much higher price than the domestic gas. The current export price for Canadian gas is $1.60 per MCF, a price which sets fuel oil and natural gas at an equivalent cost per BTU. Former Energy Minister Donald Macdonald recently stated that Canadian natural gas exports to the United States must be reduced and demand in Canada restrained until further supplies are available. The reduction of natural gas imports from Canada is not expected to have a significant impact on highly dependent areas of northern Minnesota in the 1975-76 heating season. However, there is no guarantee of continuing readily available supplies from Canada. The Canadian problem can be eased by the use of interconnections between the larger pipeline systems.

A new major source of supply may be available to Minnesota as early as 1981 (Northern Natural's estimate, but delays have occurred). The Artic Gas organization, composed of American and Canadian gas, oil, and energy-related companies, have proposed a pipeline project that would transmit gas from the Prudhoe Bay area in northern Alaska, across Canada, and through the southwest corner of Minnesota. If this is approved,

Northern Natural could increase its supply to Minnesota by an estimated 66-73 BCF. This is over 20 percent of present supplies to Minnesota.

Another promising source of future gas supplies lies in northern Minnesota's peat lands, which are discussed in the "Alternative Energy Sources" section of this report. Use of Minnesota's peat for the production of synthetic gas could provide more than 225 times the natural gas used in Minnesota in 1974.

Transmission Sector

The transmission sector transports gas from the field to the "city gate" of gas distributors. Northern Natural Gas is the state's largest transporter of natural gas. The remaining pipelines include Midwestern Gas Transmission Co., Inter-City Minnesota Pipeline, Ltd., and Great Lakes Transmission Co., which transport the gas purchased from Canada. The major U.S. users of the Midwestern and Great Lakes Systems are the States of Wisconsin and Michigan.

The wholesale, or "city gate", price is also regulated by the Federal Power Commission. This is the price the pipelines charge the gas utility distributors. In the 12 months ending in April, 1975, the average wholesale price paid by the Minnesota Gas Company, the state's largest distributor, was 62 cents per MCF, up 10 percent from 1971.

Distribution Sector

There are 24 utilities distributing natural gas in Minnesota. The table below shows the breakdown of gas sales among the largest of these utilities:

Distributor	Percentage of Total State Supply
Minnesota Gas Company (Minnegasco)	40%
Northern States Power Company	22%
Peoples Natural Gas (Division of Northern Natural Gas)	18%
Others	20%
TOTAL	100%

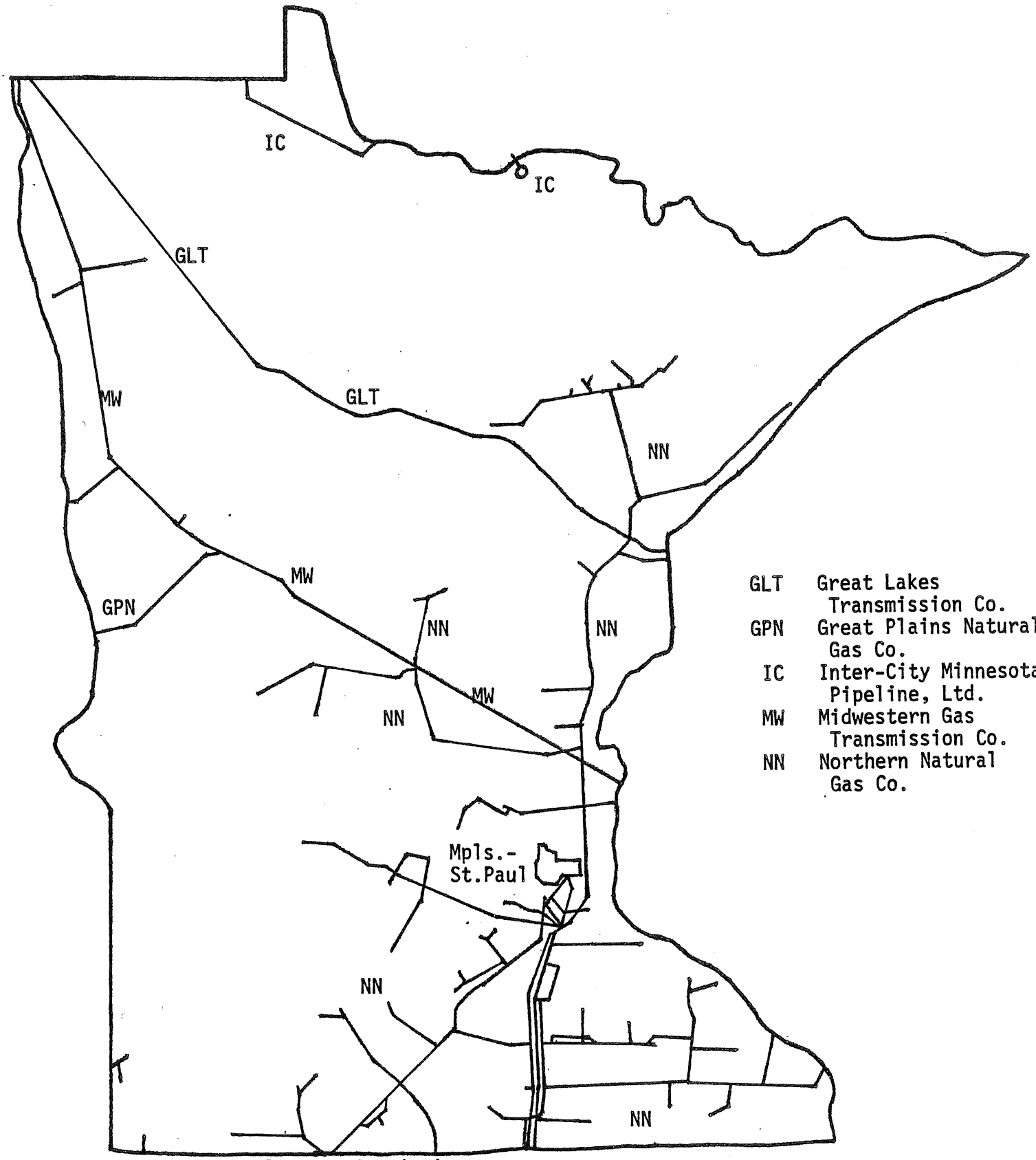
The Minnesota Gas Company, Minnegasco, is the largest distributor in the state. The following table shows how its rates have changed in recent years:

Sectors using gas for heat	1971 $ / MCF	increase	1973 $ / MCF	increase	1975 $ / MCF
Residential (firm)	1.19	8.4%	1.29	20.9%	1.56
Commercial (firm)	.98	7.1%	1.05	28.6%	1.35
Industrial (firm)	.93	7.5%	1.00	30.0%	1.30
Commercial & Industrial (interruptible)	.42	21.4%	.51	47.1%	.75

Congress currently is considering legislation to deregulate the wellhead price of natural gas. It this occurs, the increased cost to the consumers would vary. Wellhead costs are only about 19 percent of the residential gas user's purchase price. Industrial and electric generation gas users by comparison buy gas at a price close to the wellhead level. Therefore, although they pay substantially less than residential consumers for gas, their added gas costs due to deregulation would be proportionately greater. Any increase in wellhead price would be passed directly through to the consumer.

The rate for distributing gas from the "city gate" of the gas utility to the customer was regulated by municipal commissions

PRINCIPAL NATURAL GAS PIPELINES



Source: Federal Power Commission

prior to 1974. In March, 1974, the Minnesota Legislature enacted a law providing for state regulation of electrical and natural gas services by the Public Service Commission. This law has been in effect since January 1, 1975.

Natural Gas Curtailment

Pipeline suppliers have reduced their gross system output because of shrinking natural gas reserves. Northern Natural foresees an average five percent annual drop in its supplies over the next five years (FPC Docket No. CP76-45). This means that its largest volume interruptible customers (including electric generation) will be completely cut off by 1979 to allow the pipelines to continue to serve residential and commercial customers.

The curtailment of 100 percent of Northern Natural Gas' large-volume interruptible industrial customers by 1980 would result in a requirement of an additional 89 trillion BTU from other energy sources in Minnesota. This is a curtailment with a replacement equivalent of approximately 643 million gallons of fuel oil assuming no losses in efficiency. At present, it is very doubtful that such a large quantity of additional oil imports-equivalent to over 50 percent of the total fuel oil used in Minnesota in 1974 - would be available to the state. With declining supplies of Canadian crude oil, and physical limitations to the amounts which can be brought into this region from other domestic sources, fuel oil is a questionable source of replacement for curtailed natural gas.

Beyond 1980 the natural gas situation becomes very unclear because of the complex interactions of four variables:

1. The possibilities of domestic production increases due to increased exploration or deregulation of natural gas prices.

2. The possibility of a moratorium of new natural gas hookups.

3. The quantity of Alaskan gas which may be available for use.

4. The switch over of large volume firm gas customers e.g. taconite plants, to interruptible status.

The worst case would require actual curtailment of existing firm gas customers due to lack of supply by 1985. The best case (Northern Natural, FPC Docket No. CP76-45) would produce a level of gas about equal to projected 1978 supplies. This amount of gas would cover the needs of residential and commercial users and leave some gas for small volume interruptible customers. If this best case Northern Natural supply were coupled with peat gasification, the Minnesota supplies could in 1985 exceed the amount Northern Natural sold in Minnesota in 1974 (307 BCF). The following graph illustrates the 1980-85 situation.

The curtailment of interruptible customers is based on a Northern Natural plan approved by the FPC. It is in substantial agreement with FPC's priority schedule which puts large volume interruptible customers at the bottom and residential customers at the top of the schedule. One problem is that the FPC priorities do not consider critical industrial processes which require either natural gas or propane. The curtailment of critical process gas could cause economic dislocation when coupled with a propane shortage. A decrease in the supply of natural gas will also decrease the supply of propane since these are joint products from most gas wells (65 percent of all the propane

PROJECTED NATURAL GAS CONSUMPTION ON

THE NORTHERN NATURAL GAS SYSTEM [1]

1975 - 1980

Customer Class	Actual Consumption 1973	Actual Consumption 1974	Projected Consumption 1975	1976	1977	1978	1979	1980
Residential/Commercial and small Industrial	161.2	175 [3]	180 [5]	185	190	195	201	206
Firm Industrial	52.4 [4]	43 [3]	43	43	43	43	43	43
Large Volume Interruptible	49.7 [4]	50.5 [3]	44	26	21	14	6	0
Electric Utility	56.7 [4]	38.5 [3]	23	6	0	0	0	0
TOTAL Supply	320.0 [2]	307.0 [2]	290	260	254	252	250	249

Total Curtailment 1975-1980 = 58 BCF

1 Unit of Measure Billions of cubic feet (BCF).

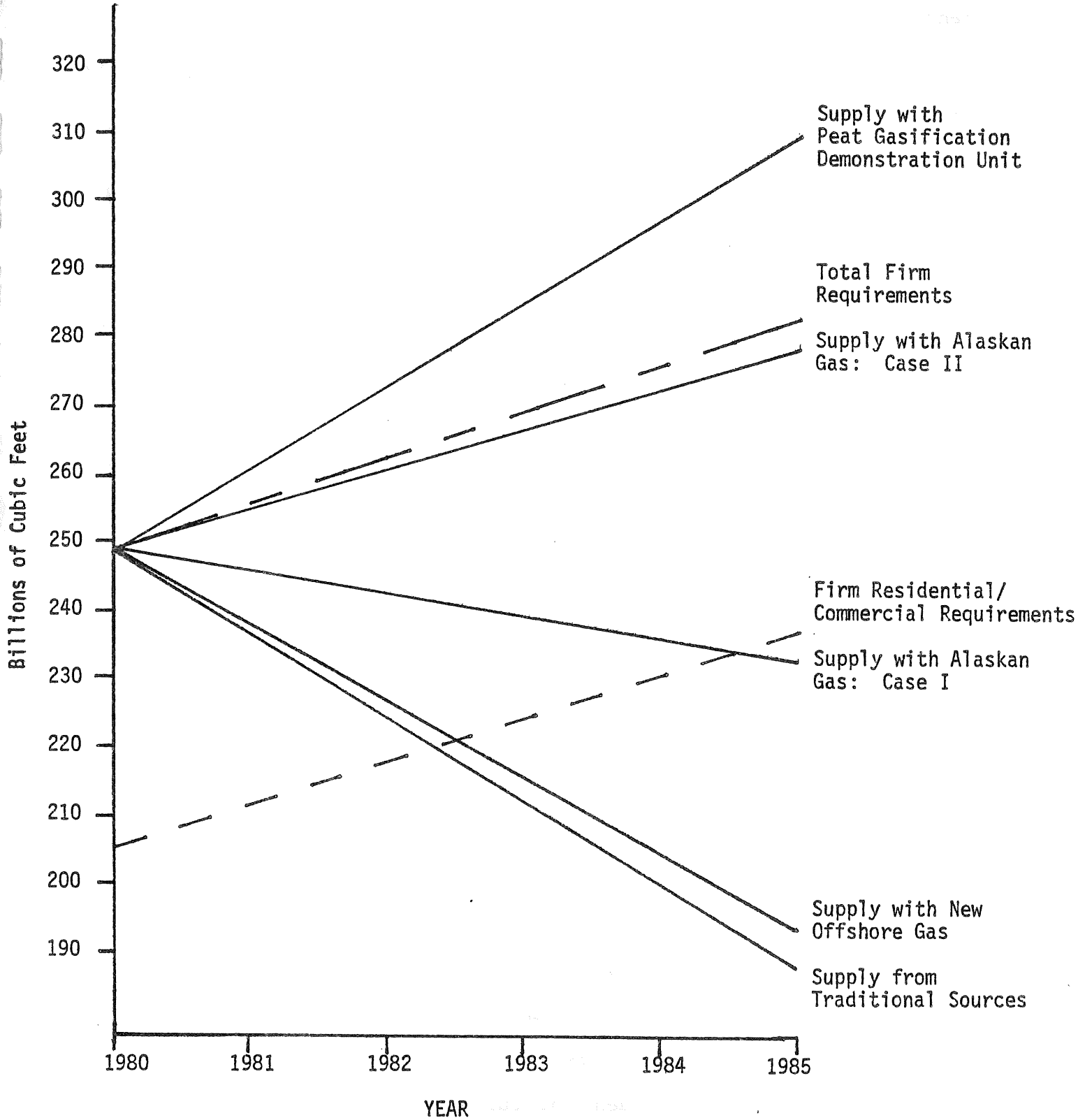
2 Based on NNG FPC 2 annual reports.

3 Testimony by Gordon Severa (NNG) before the Joint Economic Committee hearing in Minneapolis, 10/14/75

4 Allocation based on sales data for all large volume customers on the NNG System.

5 Residential/commercial/small industrial growth projected from models at an average growth rate of 2.8%/year through 1980.

MINNESOTA'S NATURAL GAS SITUATION
1980-1985



used in the U.S. is a by-product of natural gas production). The FPC should develop a curtailment procedure which allows critical processes to use gas even if this results in additional curtailments of gas used for space heating and boiler fuel purposes.

Northern Natural's new curtailment schedule filed on Dec. 31, 1975, has as its primary features the changing of large volume firm customers to interruptible status at the end of their current contracts, and a new and more sophisticated priority list containing 11 categories rather than the nine the FPC has suggested. It is expected that this plan will generate considerable discussion prior to its acceptance. Northern Natural will also file a new supply/demand (load balance) document in mid to late February. The Energy Agency will monitor both of these developments and evaluate their impact on the state.

New Residential Hookups

Since the FPC has declared that residential use of gas has the highest priority, the FPC implicitly is encouraging hookups of new residential customers. The gas saved by industrial curtailments can be made available to the residential market by building new storage facilities since the gas must be stored in the summer for use in the winter. The means of storage can be either injection of the gas into underground caverns or liquefaction. Either method requires substantial capital investment (approximately $40-50 million for 2 BCF of gas liquefaction capacity). The capital investment required to make all of the curtailed gas available to the Minnesota residential market could approach 1.5 billion dollars. Replacement of curtailed gas is an extremely

complex issue which will most likely be settled by the FPC. The question requires a complete analysis of capital costs, pipeline system capacity, existing contracts, and alternative energy suppliles. This whole question of new residential gas hookups requires systematic analysis because of the interaction between gas and electricity and the heavy capital requirements of meeting the seasonal residential demand.

PROPANE

Propane is a hydrocarbon product which bridges the gap between natural gas and petroleum. On a nationwide basis natural gas wells produce 65 percent of the nation's propane; petroleum refining yields the other 35 percent. Historically propane has been a low priced by-product from the production of natural gas and petroleum products. Because of this history, propane marketing has developed independently from both natural gas and petroleum. While many large companies sell propane wholesale, retail sales are dominated by small independent dealers. The lack of vertical integration within the propane industry has caused the product to be traded as a commodity, with large independent brokers controlling relatively large volumes of propane in storage.

Propane is a gas at normal pressures and temperatures. It is an excellent replacement for natural gas since it is clean burning and can usually be used in equipment designed for natural gas. In fact, natural gas utilities inject a mixture of propane and air into the pipeline when local demand exceeds the contracted supply amount. This propane/air injection is usually called peak-shaving. Propane can be liquefied at moderate pressures so that it can be stored as a liquid in a pressure tank and used as a gas. Most propane is transported as a liquid in both pipelines and trucks. Propane storage tanks, even at the residential level, are pressure vessels which contain liquid propane.

Structure of the Propane Industry in Minnesota

Most of the propane used in Minnesota comes from one of four sources: Canadian imports, refinery products, pipeline shipments, and imports by truck and rail from Kansas or Oklahoma.

The Minnesota Energy Agency has attempted, without much success, to define the quantities of propane received from each of these sources. The Federal Energy Administration has also tried to gain the same information about propane marketing with about the same success. The reasons for the lack of success are:

1. Propane use is highly seasonal and the product produced in the summer is stored for winter use. This storage commingles product from a variety of sources.

2. The propane pipeline company enforces its own allocation scheme (For every gallon taken in the summer three gallons can be taken in the winter.)

3. Propane in storage is treated as a commodity so it may change hands several times without being physically moved.

4. Large industrial users purchase propane in storage for their own use.

5. Retail dealers purchase propane on a "when/as/and if available" basis, F.O.B. the point of sale. They then do not report the imported quantities to the FEA.

Since propane volumes are small relative to other products (about 500,000,000 gallons in Minnesota in 1975), and since hard data is so difficult to obtain, propane remains a presistent problem for the Energy Agency.

Propane Issues

The use of propane is critical to many applications as it is an easily transportable product which can be used as a

clean burning gas. These features helped push propane as a general purpose fuel in rural areas. The major uses of propane are for rural space heating, water heating, cooking, and crop drying, as an alternate fuel for interruptible natural gas customers, and as peak-shaving gas for natural gas utilities.

Propane shortages have been predicted for the last three to four years. Other than spot shortages during the fall of 1973, none of the predicted shortage have materialized, but the possibility still exists. The persistent difficulty in obtaining hard data makes it hard to determine if there will be a shortage and, if so, whether the shortage is due to true supply problems or to the market strategies of the traders. Small users and small dealers are to a large extent dependent upon the trading actions of the large companies and producers. In the past this was no particular problem as the product was cheap and available.

The critical issue is whether some form of regulation is necessary to protect the traditional small users in the face of demand pressure from non-traditional or large users. The Minnesota Energy Agency will continue its efforts to define the demand for and the expected supply of propane. If necessary, the agency will suggest methods by which the state can force the collection of better and more accurate data.

COAL

Coal, unlike oil and natural gas, is an encouraging area in terms of the energy supplies available to Minnesota. Although Minnesota has no coal reserves itself, it has the geographic advantage of being close to the nation's largest coal reserves in the Northern Great Plains region.

This doesn't mean there are no problems. The expanded use of coal poses serious land reclamation, transportation, capital-use, and air quality problems.

As an energy resource, coal is enjoying a revival. This black, combustible rock, formed over millions of years through the compaction of plant remains, was the nation's dominant energy resource during the last half of the 19th Century. By 1900, coal was providing 90 per cent of the nation's energy demands. The growing energy needs of the 20th Century, however, were met largely by cleaner, cheaper and easier-to-use fuels -- petroleum and natural gas. The amount of coal mined has remained fairly steady, but as the nation's energy use has soared, coal has provided a smaller and smaller percentage of this energy, dropping to about 17 per cent in recent years.

Minnesota now obtains about this same share of its energy from coal, but coal use here has not followed the national pattern, as the state never was as dependent upon coal as the rest of the country. Coal use has increased steadily in Minnesota from about 5 million tons in 1955 to 7.5 million tons in 1965 and nearly 10 million tons in 1974.

The coal use in Minnesota dipped last year to about 8.2 million tons, but this was an anomalous event. Since

coal in Minnesota is largely used to generate electricity, the coming on line of nuclear generating plants reduced last year's coal requirements.

Users[1]

Unlike consumers of other forms of energy, individual coal users can be readily identified. The conversion of most residential heating to more efficient, more economical fuels, has resulted in a marked reduction in the size of the coal burning community. Known users of coal in the state now number fewer than one hundred. Those users who remain fall into one of two categories: those whose operations are large enough to support the technology required to make efficient use of coal, and those who are trapped by outmoded equipment and spiraling replacement costs. Both are required to file reports; the large users because of their size and type of operation, and the small users due to inefficiency and excessive emissions.

---

[1] Much of the information on this coal section is drawn from M. D. Lenarz, An Overview of the Coal Industry in the State of Minnesota, May 1975. This study was commissioned by the Energy Agency as part of the REIS project.

Coal Use in Minnesota in 1974

Sector	Thousand Tons	Percentage
Electric Utilities	7728	79.9
Coke and Gas Plants	725	7.5
Retail Dealers	237	2.5
All Others	977	10.1
Total	9,668	100.1

The table shows that 80 per cent of the coal burned in the state is used to generate electricity. Well over 90 per cent of this amount is burned by the three largest utilities, Northern States Power Co., Minnesota Power and Light, and the Otter Tail Power Co. This greatly simplifies the task of determining who is using coal, its source, and how it is being used.

Large industrial users in western Minnesota depend heavily on lignite, a low-grade coal mined in North Dakota. Most of these users supplement lignite purchases with coal purchases under contract from Great Lakes Coal and Dock, the C. Reiss Coal Company, and others. Other industrial users as well as the smaller utilities buy their stocks through the same wholesale dealers or from the mine-mouth.

Western coal now makes up two-thirds of the total coal supplied to Minnesota. If the expansion of steam-electric generating facilities requested by the utilities occurs, the state will be even more dependent on Western coal.

Distributors

Wholesale coal operations in Minnesota are dominated by two companies, the Great Lakes Coal and Dock Company of Milwaukee and the C. Reiss Coal Company of Sheboygan, Wisconsin. C. Reiss has dock facilities in Duluth and distributes by rail and truck throughout northern and north-central Minnesota. Great Lakes has port facilities in Duluth and a river dock in St. Paul and services the southern half of the state and most of the metropolitan area.

Retail sales account for a very small percentage of the coal used in Minnesota, and as a percentage of the total retail sales will continue to decline as the cost of coal rises and small users convert to more efficient forms of space heating.

Transportation

Nearly three-fourths of the coal used in the state is shipped in by rail, as shown in the table. The largest use of the 10.2 per cent shipped via the Great Lakes is by coke and gas plants, which require Eastern coal, with its higher energy content. The 17.5 per cent of the coal brought in by barge is used largely (90.2 per cent) by electric utilities.

Transportation of Coal into Minnesota in 1974

Transport Mode	Thousand Tons	Percentage
Railroad	6,988	72.3
River Barge	1,696	17.5
Great Lakes	984	10.2
Total	9,668	100.0

Both water routes into Minnesota are impassable during the winter. This requires large coal inventories by those using these transportation routes. The increased cost of large stockpiles partially offsets lower water freight rates.

The 72.3 per cent of the coal transported to Minnesota by rail is mostly from the Western producing region. Electric utilities receive 80 per cent of these rail shipments.

The major generating plants either under construction or scheduled for construction during the latter part of the 1970's and the early 1980's are designed to burn Western coal. When these new plants become operational, their combined requirements for coal will triple the current annual consumption. This coal will have to be transported by rail. The link between Minnesota and the coal fields of the Northern Great Plains will become vitally important to the satisfaction of Minnesota's energy needs.

Burlington Northern Railroad operates the major trunk line into Minnesota from the Western Plains. Moody's Transportation Manual for 1974 states that 40 percent of the nation's economically mineable coal reserves are located within Burlington Northern's territory.

Burlington Northern owns mineral rights on 6,150 million acres of land with approximately 11.4 billion tons of economically mineable coal reserves. About 5.4 billion tons of these reserves are under lease. In recent years there has been a reduction of leasing activity by the company since one of Burlington Northern's

objectives is to gain an equity position in the industries which mine coal or manufacture products from coal. Recent coal leases contain options for Burlington Northern to participate in mining, plant construction, or operation whenever a decision is made by the lessee to begin such a project.

Future Demand.

During the past 10 years, the use of coal in Minnesota has been increasing at about an average annual rate of 4 percent, roughly the same rate as the increase in total energy use. There is little doubt that coal use here will increase both in volume and in its share of the state's energy use.

The question is how fast. Many of the decisions to increase coal use already have been made, contracts signed, and the necessary approvals obtained. Other expansion plans are before state agencies.

The Northern States Power Co. is constructing Units 1 and 2 (680 megawatts each) at its Sherburne County generating plant near Becker, Minnesota. These units, scheduled to come on line in 1976 and 1977, will consume 544 million tons of coal annually.

NSP also plans to add Units 3 and 4 at the Sherburne County facility. If these plans are approved, these new 800-megawatt units would become operational in the early 1980's.

The Minnesota Power and Light Co. has plans for a 500-megawatt addition to its Clay Boswell generating station. If approved, this addition could be completed in 1980.

If these five plants are built as planned and the trend in coal use otherwise continues at the 4 per cent level, coal consumption in Minnesota in 1985 is projected at about 28 million tons, or more than a 300 percent increase over 1975 consumption.

Coal use in Minnesota is tied closely to the coal production of the Northern Great Plains states of Montana, Wyoming and North Dakota. The coal wealth of these states was ignored until recently. Eastern coal has a higher energy content and is closer to major coal users, causing lower transportation costs. Western coal first gained attention because of its low sulfur content, which makes it less polluting. The growing shortages of natural gas and domestic petroleum and the high cost of pollution control equipment have intensified this interest in Western coal.

The Northern Great Plains have a total reserve base of 175.4 billion tons of coal, or 41 per cent of the nation's total reserves. The Federal Energy Administration's Project Independence report projected that under "business as usual" conditions production of coal from the Northern Great Plains would nearly triple in the next 10 years (from about 53.5 million tons in 1975 to 155.1 million tons in 1985). The Project's "accelerated" projection shows coal production from the region increasing nearly sixfold to 303.8 million tons by 1985.

A report by the Upper Midwest Council[2] also projects a

2 "Northern Great Plains Coal, Issues and Options for Suppliers and Users", a Future Choices Project of the Upper Midwest Council, July, 1975.

rapid development of the Northern Great Plains coal resources. The Council report estimates the region's production at 168.5 million tons as early as 1980 and 211.5 million tons for conventional uses in 1983. The latter figure could reach 314.1 million tons in 1983 if plants are constructed to convert coal into synthetic natural gas. This clearly is an area where production developments must be watched closely to update future forecasts.

Policy

The expansion in coal use presents difficult problems in simultaneously satisfying environmental, economic and energy supply goals. The conflict over a coal transshipment site at Pigs Eye, the emerging conflict over Western water rights, siting difficulties for coal-burning power plants because of legitimate concerns about air, land, and water quality, the problems of water quality degradation from large scale coal gasification plants -- all of these issues require decisions.

The Energy Agency intends to help provide a framework for decisions concerning coal -- from mining, through transportation, transshipment, and storage, to end use. Because of the many facets to this issue, a coherent plan is required. The controversies over air quality degradation, coal transshipment, water consumption and land use cannot be treated as independent problems. The sheer magnitude of present commitments for coal use in Minnesota indicate that decisions must be made

quickly. The state cannot simply react to requests; it must develop a coal use policy which accommodates the needs of all segments of our society.

A Minnesota coal use policy should consist of plans for minimizing the adverse impact of increased coal use, an evaluation of the alternatives to increased coal use, and an evaluation of the governmental services which must accompany increased coal use. The development of a coal use policy is one of the major objectives of the Energy Agency.

ELECTRICITY

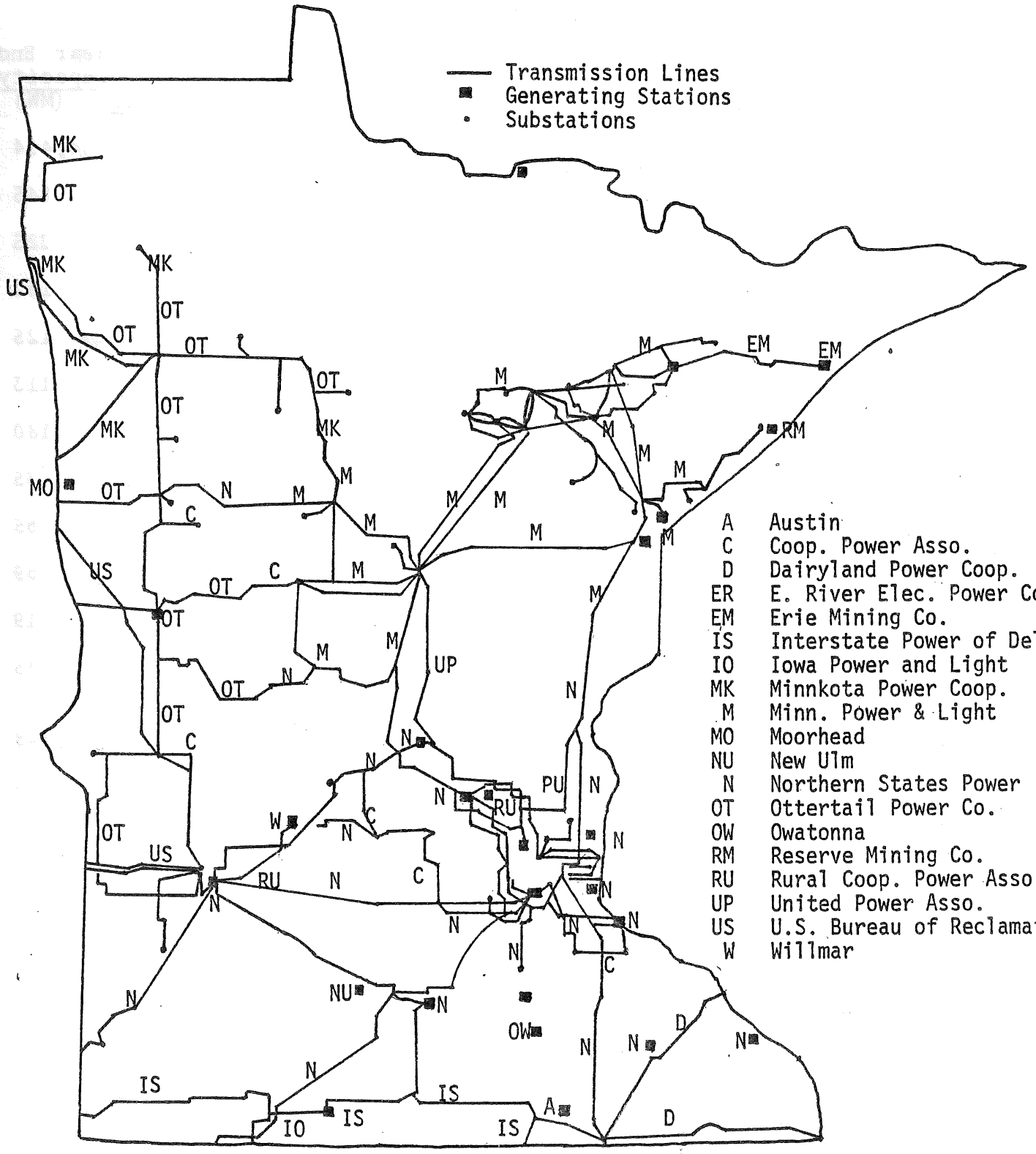
Electricity is an energy form, not an energy source. In 1975 electricity supplied Minnesota with about 9 percent of its end-use energy while oil and natural gas supplied 85 percent. Even allowing for electricity's generally higher end-use efficiency, it would take a 125 percent increase in Minnesota's current electricity supply to make up for a 20 percent reduction in oil and natural gas availability.

Supply, Current and Projected

In 1974, Minnesota consumers purchased 25.3 billion kilowatt hours (kWh) of electricity from electric utilities. To supply this energy (after line losses), 21.2 billion kWh was generated in Minnesota and another 4.9 billion kWh, or 19 percent of the total, came from net imports. In addition to these amounts, private industries generated 3.0 billion kWh for their own use. Most of the electricity generated in Minnesota (80%) was produced using coal and nuclear fuels, with natural gas (12%), oil (4%), and hydroelectric generation (4%) making up the remainder.

It takes approximately 10 years to plan, site and build an electric generating facility in Minnesota. Therefore, Minnesota's supply of electricity between now and 1985 will be limited to that produced by facilities that already exist, are under construction, or are in the permit process, plus imported electricity. If all required permits are granted and all facilities now under construction or planned are completed on schedule, Minnesota utilities will increase their total generating

PRINCIPAL ELECTRIC FACILITIES



Source: Federal Power Commission

TABLE 1

Large Electricity
Generation Systems
In Minnesota
1974

Type	Name	Net Generation (GWH)	Pct.	Year End Capacity (MW)
Private	Northern States Power (NSP)	15,207	61	4,454
Private	Minnesota Power and Light (MPL)	3,929	16	845
Industrial	Erie Mining	1,166	5	225
Private	Otter Tail Power (OTP)	1,054	4	182
Industrial	Reserve Mining	964	4	125
Municipal	Rochester (ROCH)	414	2	113
Private	Interstate Power (ISP)	319	1	180
Industrial	Boise Cascade Paper	225	1	35
Municipal	Austin (AUST)	182	1	65
Cooperative	United Power Association (UPA)	161	1	69
Industrial	Waldorf Paper Products	123	-	19
Municipal	Owatonna (OWAT)	105	-	35
	TOTAL OF 12	23,849		6,348
	Residual	1,200	5	359

TABLE 2

GENERATING CAPACITY (MEGAWATTS)

by Fuel Type
Minnesota
1975

Hydro	136	(2%)
Nuclear	1,755	(26%)
Coal	3,099	(46%)
Oil and Natural Gas	1,712	(26%)
TOTAL	6,702	

capacity by 3164 megawatts in 1980 and 4401 megawatts in 1985. (These increases include facilities built outside of Minnesota with their outputs dedicated to Minnesota.) The only major generating facilities under construction in Minnesota that have received all the necessary permits are NSP's Sherburne County units 1 and 2, with a combined capacity of 1360 megawatts.

Of the electric energy imported in 1974, over 75% was from hydroelectric facilities owned by the United States Bureau of Reclamation (USBR). By 1977 the USBR will reduce the amount of electricity supplied to Minnesota to about 60% of that supplied in 1974. The USBR has notified many of its "preference customers", including 43 Minnesota municipal utilities, that it will not be able to continue to supply their growth in electrical requirements after 1977. These utilities need to make suitable arrangements for power supply to support growth in demand. Independent electric utilties and rural electric cooperatives will assume most of this additional load in the short run. In the long run the municipal utilities could either continue to purchase power, sell out to larger private utilities, or jointly build one or more generating facilities to supply their needs.

Patterns of Use

Electrical demand varies from service area to service area, from month to month, from day to evening, and from weekday to weekend. Minnesota has two seasonal periods of electrical peak demand, one corresponding to the summer cooling season and the

other corresponding to the winter heating season. During the months of April, May, September, and October the peak electrical load averages only 80 percent of the July peak. December and January peak electrical loads are approximately 90 percent of the July peak. The fact that loads vary from month to month allows the utilities to schedule major maintenance during months of lower peak demand.

Daily peak loads occur as early as 10 a.m. or as late as 7 p.m. depending on the time of year, but nighttime demand (10 p.m. to 7 a.m.) averages only 60 percent of the daily peak.

Nighttime loads on weekends are essentially the same as nighttime loads during the week. However, weekend daytime loads average less than 80 percent of weekday daytime loads.

Electrical Demand

During the past 10 years sales of electricity in Minnesota have grown at an average rate of 7.5 percent per year. If this growth rate continues, Minnesota will need twice as much electrical generating capacity in 10 years and four times as much in 20 years. Since Minnesota faces curtailments in both its natural gas and crude oil supplies, it is likely that demand for electricity will grow at even a greater rate in the near future.

The rapid growth in the past can be attributed mainly to increased industrial output and to increased use of climate control systems, labor saving devices, and "convenience" items. Since 1970, industrial electrical demand in Minnesota has been highly correlated to industrial output in the state. This represents a slight slackening of growth compared to the 1960's when widespread installation of labor saving devices caused industrial electricity demand to rise more rapidly than industrial output.

In the other major categories of electrical consumption, increased demand reflects an increasingly affluent life style in which many things previously seen as luxuries have quickly become "necessities", such as air conditioners, frost-free refrigerators, electric typewriters, data processing equipment, irrigation, crop drying, etc.

The rapid growth of mining in Minnesota during the past 10 years has also brought with it increased electricity demand. Mining now uses over 16 percent of all electricity generated in the state. Over 60 percent of this electricity is purchased from private utilities. In 1974, mining companies purchased more than 4 times as much power as in 1965. Minnesota Power and Light (MP&L), which supplies over 90 percent of the electricity sold to the mining industry, expects these sales to more than triple by 1980. MP&L projects a total mining load in 1980 as large as its existing generating capability.

Currently, less than 4 percent of Minnesota's agriculture land is irrigated. Between 1965 and 1975 the amount of electricity used in irrigation increased 25 times. In Douglas, Pope, and Grant counties electricity demand for irrigation was 65 percent greater in 1975 than in 1974. If the current growth rate continues, irrigation will become a significant part of Minnesota's summer electrical demand.

Electric utilities in Minnesota have projected and planned their future system capacity requirements on the basis of historical load data. This technique assumes that future influences on electric consumption will be consistent with past experience. However, the larger utilities in the state are beginning to take other factors

into consideration when making their forecasts, including the impacts of conservation, fuel substitution, economic conditions, and population projections. Planning capacity on the basis of historical trends would probably produce sufficient or even excess capacity in the short run if it were not for the expected supply restrictions in oil and natural gas. The amount of electricity required to replace the natural gas curtailment projected for 1980 constitutes more than 70% of all electricity generated in Minnesota in 1975. Obviously, not all of the curtailment of natural gas will result in increases in electrical demand. Some natural gas users will convert to coal or to oil. Those converting to oil, however, may find oil in short supply or too expensive. A petroleum shortage could cause rapid and massive conversions to electricity.

Because it takes approximately 10 years to plan, site and build an electric generating facility, only a small portion of lost natural gas and oil supplies can be replaced by electricity in the 1975 to 1985 period. Unless permit and regulation processes are bypassed, Minnesota's electrical capacity cannot be increased (beyond capacity already planned) before 1984.

In addition, the extent to which utilities are forced to use oil to generate electricity will in turn reduce the amount of oil available for others. Over 26% of Minnesota's existing electrical generating capacity requires either oil or natural gas as a fuel. The use of oil by electric utilities occurs when electrical demand exceeds the generating capacity of the nuclear and coal facilities that are available. Thus, the shift to electricity by current users of natural gas or oil needs to be carefully managed so that the added electrical demand does

not increase the amount of oil used for electrical generation. Specifically, use of electricity as a substitute for oil or natural gas should be encouraged only at non-peak load times when utilities are not using oil. Off-peak interruptible electric service at rates near the price of oil would be one way to achieve this goal. In addition to reducing the overall demand for oil and natural gas, increased use of off-peak power would make greater use of existing electric generating facilities benefiting all electricity rate payers.

ALTERNATIVE ENERGY SOURCES

As the energy received from traditional fossil fuels declines, energy requirements in the future will depend increasingly upon alternative energy sources. These new sources may not provide a large portion of Minnesota's energy needs in the years immediately ahead because of development lead time, but it is essential that a vigorous effort be made to develop alternative energy supplies so they will be available when they are needed.

The primary alternative energy sources in Minnesota are peat, solar energy, wind, agricultural and forest residues, urban and animal wastes, and heat from power plants. Breeder and fusion reactors, synthetic fuels from coal, and shale oil are among other new energy sources likely to be developed at the national level.

Peat

Peat is partially decayed vegetable matter whose further decomposition has been retarded by immersion in water. It is Minnesota's only known fossil fuel resource. Minnesota has over 7 million acres of peatlands, or about half of the U.S. total (excluding Alaska). About 3 million of these acres -- mostly in northern Minnesota -- contain accessible fuel-quality peat deposits. Assuming an average depth of 6 feet, these deposits could total nearly 4 billion tons of dry peat.

Research in the past has focused on peat's use as an agricultural soil conditioner and on its potential value in the manufacture of chemical products. As recently as 1970,

PEAT DEPOSITS

Source: Headwaters Regional Development Commission

a U.S. Bureau of Mines bulletin stated that "while peat is used as a fuel in many countries, it is not used for this purpose in the U.S. because of our abundant supplies of high grade fossil fuels -- lignite, coal, petroleum and natural gas -- and our excellent transportation system (pipeline, rail, highways) for delivering these fuels to consumers."

As these fossil fuels have become less abundant, however, there has been a renewal of interest in the use of peat as a fuel. Peat has a heating value comparable to lignite (about 7000 BTU/lb, depending on moisture content). Minnesota's fuel-quality peat deposits, if burned directly, could supply the state's total energy needs for over 50 years at current rates of consumption.

Peat gasification, using a process similar to coal gasification, is also being studied. The Minnesota Gas Company recently applied to the State Department of Natural Resources (DNR) for a 25-year lease on 200,000 acres of state-owned peat land in Koochiching, Beltrami, and Lake of the Woods counties. DNR has received a grant from the Upper Great Lakes Regional Commission for a preliminary assessment of the uses of peat and the environmental effects of harvesting it. If peat gasification proves technically, economically, and environmentally feasible, Minnegasco plans to build a demonstration plant in the lease area with a capacity of up to 80 million cubic feet per day. A full-scale plant with a capacity of 250 million cubic feet per day would cost an estimated $750 million, employ more than 1,000 people, and have an annual output equal to one fourth of

Minnesota's 1974 natural gas consumption. The peat in the requested lease area would provide fuel for about 20 years of continuous operation by such a plant.

Solar Energy

The annual solar energy falling on the earth amounts to nearly 30,000 times the world's annual energy consumption About one-third of this energy is reflected back out to space, and only about half actually reaches the earth surface. Even so, the total available solar energy constitutes a vast, largely untapped resource.

The use of solar energy in building heating and cooling, grain drying, and other applications is rapidly becoming a reality. The federal government has mounted a massive program to demonstrate the feasibility of solar heating and cooling in actual buildings. Solar equipment manufacturers in Minnesota and elsewhere are incorporating developed technology into systems for space heating and cooling, processing, and water heating. In the past 12 months there have been great advances in system design and implementation. From the simple flat plate design, solar collectors have become sophisticated, using slatted reflectors, solar trackers, and parabolic designs. In addition to water and rocks, salt solutions and other chemicals are being tested as heat transfer and storage media. And systems integrating solar heating with more conventional sources have been developed to provide a backup for extended cloudy or extremely cold periods when both current solar gain and stored solar energy are insufficient to provide the needed heat.

Solar heating system costs are still somewhat high. Currently available solar systems for home heating result in a cost of two to three times current oil heat cost and are capable of supplying only about 40 percent of the heating requirements of a Minnesota home. However, decreases in costs resulting from technological advances and government action could make these systems competitive in the near future. Also, when combined with energy conservation measures and innovative building design, as in the University of Minnesota's underground solar-heated book store, solar energy competes more successfully with other sources.

Solar electric generation is further from realization, but several possibilities are being studied actively at the national level. One is the concept of conventional steam electric plants that derive their heat energy from the sun. At present, two projects are in progress in the southwest using a circle of mirrors to focus the sun's rays on a "steam tower". Also under development are photovoltaic systems similar to the solar cells used to power orbiting spacecraft. Solar energy falling on a thin piece of silicon semi-conductor will generate a voltage between the top and bottom surfaces of the silicon. This direct conversion of sunlight into electricity is simple, reasonably efficient (perhaps up to 20 percent), and suitable for both large and small installations. Recent advances suggest that continuing development of crystal growing technology may in time make such a system economically feasible.

Systems for storing solar electricity will also be needed. Individual buildings probably will use conventional lead-acid batteries. Large solar electric systems may use excess electricity to separate water into its constituents, hydrogen and oxygen. The hydrogen can then be stored, transmitted by pipeline, and used as a gaseous fuel in much the same way as natural gas. The conversion of electric energy into hydrogen and back into energy involves waste at each step, but the gain in convenience of storage may make it worthwhile. Proponents speak of a future "hydrogen economy" in which several types of renewable energy resources are converted into hydrogen, which can be burned in gas stoves or furnaces or other appliances or perhaps even used as a replacement for gasoline in motor vehicles.

Governor Wendell Anderson has already acted to promote Minnesota's solar capabilities by issuing an executive order creating a task force to prepare a proposal for the national Solar Energy Research Institute (SERI). A number of Minnesota businesses and academic leaders long active in the solar energy field are participating in this effort. In addition, the University of Minnesota and the Minnesota Energy Agency co-sponsored an Update on Solar Energy Technology and Applications seminar January 14, 1976. The state could undertake a number of other actions to encourage the use of solar energy, including:

The use of solar energy, other alternative energy sources, and innovative designs, such as partial underground construction, in any new building projects.

Passage of measures to provide standards for solar equipment so that buyers would be assured of the performance of new solar products.

Development of a solar rights law. One interesting issue is whether the construction of a solar collector creates an easement that prevents a neighbor from blocking the sunlight.

Revision of building codes to stimulate the use of semi-underground and underground building. Ten feet below the surface the temperature changes only about 4 degrees from summer to winter in Minnesota so energy requirements would be greatly reduced underground and energy requirements would be far more constant year around.

Wind

Experience has shown that wind-energy conversion systems can be built and operated successfully. Accurate projections of potential wind-power market penetrations will depend on costs, service life, maintenance requirements, and applications, but it is possible that 20 per cent of Minnesota's electrical power demands in the year 2000 could be supplied by wind power systems.

Boeing estimates 5000 megawatts of wind power is theoretically extractable in Minnesota. The estimate is based on 8,000 to 10,000 square miles of high wind area which could hold one windmill per square mile. Estimates of practical extraction indicate that Minnesota may have the equivalent of 1000-1500 MW of large scale wind capability. Small

windmills for farm use may add an equivalent amount of energy.

Wind-power systems produce no air or water pollution and little noise -- only a quiet swishing sound can be heard when you stand under the large propeller-type rotor. However, the "visual pollution" imposed by the wind plants and the transmission lines to feed into a power network could be a problem, especially if care is not taken to make the plants esthetically appealing. There may be a need for new roads to reach high altitude wind plant sites, and introducing large numbers of windmills into a small geographical area might cause minor changes in local weather conditions.

The U.S. Energy Research and Development Administration (ERDA) has given Honeywell, Inc. a contract of $172,000 to study the practicability of using wind generators for the production of electricity. Honeywell will develop computer simulations of the average wind conditons in the Minnesota Power and Light Company service area, and combine them with generator data from Boeing-Vertol to establish how much electricity could be produced if wind generators in various numbers and combinations were available to Minnesota Power and Light. The utility will then determine what the economic effects on its operation would be if wind generators were brought on line.

The Honeywell-MP&L program together with Minnesota's high average wind velocity (11-12 miles per hour yearly average state-wide) should put Minnesota in the forefront of wind energy development.

Agricultural and Forest Residues

Agricultural field residues hold potential as one piece of the supply puzzle for Minnesota. If current estimates of collection costs of $10 to 15 a ton hold up under actual conditions, residues are definitely competitive with coal for some uses.

If all of the residues generated in Minnesota could be used for energy, we could derive 40 percent of our current use from this source. A more realistic estimate is that we could use 15 percent of the state's agricultural residues, thereby generating 6 percent of our energy needs. The potential of this source therefore appears similar to the potential of the Minnegasco peat proposal.

The use of agricultural residues for energy poses collection, transportation and environmental problems. The next step should be a pilot program to test the concept by collecting the residues from several farms, transporting them for use in a heating plant or an electric generating facility and using them there for fuel. Energy, cost, engineering, and environmental data could be collected to determine the feasibility of the project.

The University of Minnesota's Center for Studies of the Physical Environment has done considerable research in the use of agricultural residues and other forms of biomass to generate electricity. The center has proposed a research project that is being considered by the Pollution Control Agency's board.

In a related area, the energy available from the annual production of litter in the forest industry is equivalent to 17 percent of the state's total energy requirement. Before this energy source can be effectively utilized, collection, transportation and use systems must be developed and their technical, economic and environmental feasibility demonstrated. This energy source is concentrated in the less developed areas of the state so that transportation may be a significant barrier to commercialization. A development program for timber residues should be studied since they are a local, renewable resource which could be a significant benefit to the state.

Energy from Urban Wastes

Minnesota is in a unique position to utilize a high percentage of the energy available in urban wastes. There are 1,557,000 tons of shredded refuse available each year in the Twin Cities metropolitan area alone. At a heating value of 5000 BTU/lb this is equivalent to 100 million gallons of fuel oil or 28 per cent of the refining output of Conoco's Duluth-area refinery. If the energy from urban wastes in all the other communities of the state could be harnessed, urban wastes could provide 2.7 per cent of the total state energy requirement annually.

The Metropolitan Waste Control Commission recently rejected a project to convert urban wastes into fuel by means of pyrolysis on the grounds that it has not yet been proven technically and economically feasible. However, plans are proceeding for a private installation which will use garbage

as a supplement to coal for direct burning at the Hoerner-Waldorf Co. plant in the Midway area of St. Paul.

Energy from Animal Manures

Animal wastes are a potential source of energy. Manures with a gross heating value of over 90 trillion BTU are produced annually in Minnesota. However, most farms have small herds and relatively small amounts of manure in any one location. Therefore, only a fraction of this energy is likely to be recovered and converted into useful energy or fuel. Energy recovery may be considered in conjunction with manure treatment to improve fertilizing quality while minimizing environmental degradation.

The commercial feasibility of producing methane gas from cattle manure has been demonstrated. In October, 1974, Peoples Gas Co. of Chicago announced that it had agreed to buy an annual volume of 640 million cubic feet of gas produced by means of anaerobic digestion from 90,000 tons of cattle manure. The bio-gas plant, located near several feed lots in the Panhandle area of Oklahoma and not far from existing natural gas pipelines, is scheduled for completion in mid-1976.

Using Heat from Power Plants

Electric generating plants operate at efficiencies ranging from 25 to 35 per cent, with the newer plants usually being more efficient. This means that the energy value of the electricity generated is about 25 to 35 percent of the energy value of the fuel used to generate the electricity. The remaining 65 to 75 per cent of the energy

is discharged as waste heat into rivers or lakes or into the atmosphere through cooling towers.

This "waste heat" is a potential source of energy. For example, if the heat from Northern States Power's Sherburne County 3 and 4 units could be delivered for home heat with an 80 percent efficiency, these two generators alone could supply 38 per cent of Minnesota's residential and commercial winter time heating needs.

In addition to such district heating, heat from power plants could be used for growing food in gigantic greenhouses. NSP is testing this concept in a demonstration half-acre greenhouse at its Sherburne County facility in a joint effort with the University of Minnesota and the U.S. Environmental Protection Agency. If the experiment is successful, a 100-acre greenhouse could be operating there by 1985.

ENERGY CONSERVATION

The energy supply situation described in the foregoing sections makes it clear why the statute creating the Minnesota Energy Agency instructs its director to design a state energy conservation program and why this is one of the most important provisions of the law.

Conservation Plan Framework

A conservation program must be more than a series of isolated conservation efforts. It must start with a comprehensive analysis of how energy is used followed by an inquiry into what the state can do to promote energy efficiency. It must be organized around short, middle, and long term goals, and various implementation strategies. A conservation plan is a series of conservation efforts organized to provide maximum benefit to the community. The Legislature indicated it wanted this kind of plan when it instructed the director in Minn. Stat. 116H.07 (i) to:

> Design a state program for the conservation of energy; this program shall include but not be limited to, general commercial, industrial and residential areas; such program shall also provide for the evaluation of energy systems as they relate to lighting, heating, refrigeration, air conditioning, building design and operation, and appliance manufacturing and operation

Role of Energy Conservation

Energy conservation has been seen too often in the past as a "nice idea" that stood apart from other energy policy matters. This attitude must change if conservation is to get the serious attention it requires. Conservation needs to be regarded as an essential element in energy policy decisions.

The development of an energy policy, at either the national or state level, involves projecting energy supplies, projecting energy needs, analyzing the anticipated gaps between supplies and needs, and designing programs to close such gaps.

Energy need may not be the same as energy demand. Historical consumption may not be a good indicator of future need. Energy use patterns will change, and factors affecting demand may move in unanticipated directions. In this setting, conservation planning becomes a sophisticated endeavor, which raises the question: What energy use really is needed by the society to meet its goals?

Energy consumption is not a societal goal. To meet society's objectives while using less energy makes money available for other purposes and saves energy for the future. Conservation also has many other benefits. Reducing the demand for energy through conservation reduces the stress on the development of traditional energy supplies, diminishes the likelihood of an energy "crisis", and provides more time for the development of alternate energy sources. From the most cursory analysis, it is clear that the cheapest, cleanest and most quickly available source of energy is conservation.

Conservation Strategies

There are four ways to achieve energy conservation objectives. First, there is education. This can range from "jawboning" - the exhortation to dial down and up, insulate, car pool, etc. - to comprehensive demonstrations of the feasibility of conservation programs. The second is the market system - the raising of the price of an energy resource until supply and demand meet. The third is incentives - tax credits, loans, and subsidies designed

to encourage investment in energy-saving equipment. The fourth is the regulatory method -- that is, the use of federal, state, or local statutes and regulations to prohibit certain kinds of energy uses or to allocate available supplies.

The desirable conservation plan is a consistent combination of these elements. Education programs must be based upon credible and pursuasive information. Some price increase is necessary to convince users that a product should be more highly prized. Where the simpler tools fall short of a conservation objective, there is a need for skillfully drafted legislation to provide incentives or regulation.

The State's Role in Conservation

There is a growing recognition that states should play a key role in energy conservation programs. Energy use varies greatly from state to state. It depends upon the state's climate, its available energy resources, its industrial mix, its agricultural character, its size and the number and distribution of its citizens.

In Minnesota, energy use is fairly evenly divided between four sectors - residential and commercial (28%), industrial (20%), transportation (27%), and electric generation (25%). The Energy Agency's conservation plan is based on a sector by sector analysis of energy uses.

In each sector, the conservation efforts already underway or planned may be subdivided according to responsibility level, time horizon, and implementation strategy. Responsibility can be divided between the Federal government, State government, local government, and the private sector. Time horizons can be

divided into this year and the future. Implementation strategy involves the choice among possible administrative or legislative actions to achieve the desired goal. These distinctions will be made in the comments on each conservation activity.

This is the agency's first effort in developing a comprehensive energy conservation program for Minnesota. A conservation program is a changing, dynamic effort. During the course of 1976, the Agency will analyze its conservation efforts to determine what is working and what is not. This will lead to a revised conservation program which will be presented to the Governor and the Legislature at the start of the 1977 legislative session.

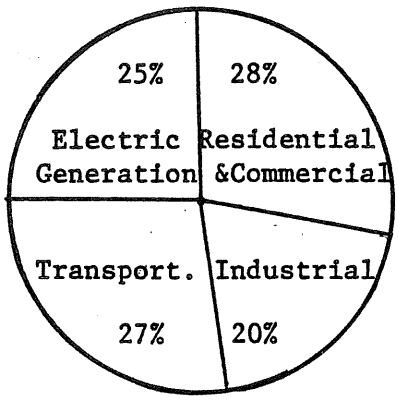
Residential and Commercial

As shown in the following figure, the residential and commercial sector was Minnesota's largest energy user in 1974, consuming 28% of the state's primary fuels and 55% of its electricity. This amounted to a net energy consumption of 352 trillion BTU, or 40% of the state total.

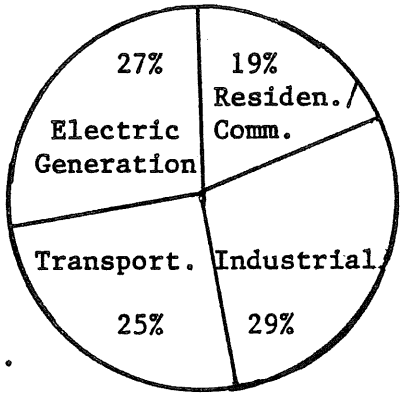
Space heating is by far the largest energy use in the residential and commercial sector, making up 70% of total energy use and an even higher percentage of natural gas, heating oil, and propane consumption. Residential and commercial space heating is therefore an obvious area where significant energy savings are possible and is a major focus of the Minnesota Energy Agency's conservation plan. Other major uses which should be given special attention are water heaters, other heat-producing appliances, and air conditioners.

ENERGY CONSUMPTION BY SECTOR, 1974

PRIMARY FUELS

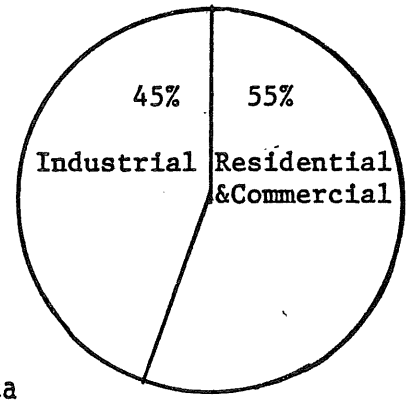


Minnesota

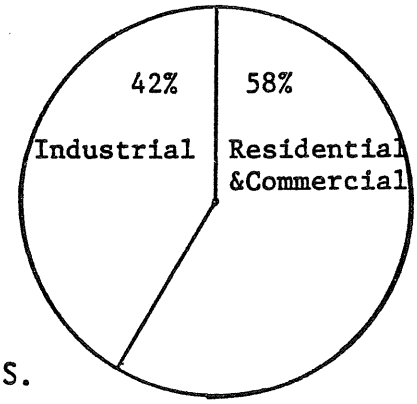


U.S.

ELECTRICITY

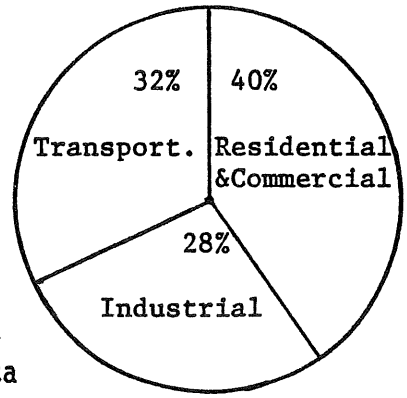


Minnesota

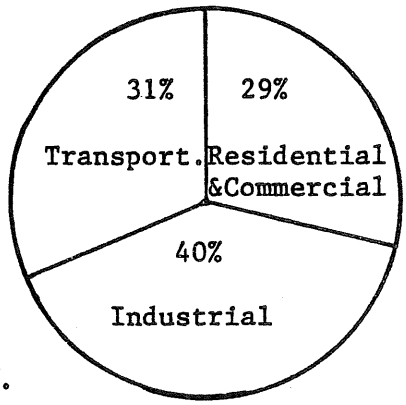


U.S.

TOTAL NET ENERGY



Minnesota



U.S.

Current Programs

As outlined in the "Agency Programs" section of this report, the Energy Agency has a number of conservation programs for residential and commercial buildings already under way.

The Agency has worked with the state Building Codes Division to develop and implement energy efficiency standards for new and remodeled buildings as mandated by Minn. Stat. 116H.12, Subd. 4. Adoption of such building standards is one of the mandatory elements of state conservation plans under the national Energy Policy and Conservation Act (PL 94-163) recently passed by Congress.

To reduce the space heating energy requirements of existing buildings, the Energy Agency has pioneered in the development of "energy audit" procedures for schools, hospitals, and other public buildings as well as in infra-red photography for detecting heat loss. Agency staff members have advised and assisted economic opportunity and community action organizations with the federally funded winterization program (assistance to low-income homeowners to upgrade their insulation). A bill to expand this program is now under consideration in Congress.

To reduce residential and commercial energy use for water heating, lighting and appliances, the recently passed federal Energy Policy and Conservation Act (PL 94-163) provides for mandatory energy efficiency labeling of appliances and the establishment of energy efficiency goals for new appliances. In addition, lighting standards for public

buildings and energy standards for equipment procured by the state government are required to be included in state conservation plans submitted under the act.

This Year

The Legislature can take several additional actions this year to increase energy conservation in Minnesota's residential and commercial buildings. HF 1137, which passed the House in 1975 and is now before the Senate, would provide $6 million in loans to improve the energy efficiency of homes owned by low and moderate income people. HF 1437, under consideration in the House, would direct the development and implementation of energy standards for schools and the performance of energy audits on state owned buildings, ban decorative gas lamps, require new gas appliances to have electric igniters rather than pilot lights, and set a mandatory minimum efficiency standard for room air conditioners. Additional bills are expected to be introduced to direct the retrofitting of other public buildings, the establishment of solar energy equipment standards, and the creation of incentives for use of solar and other alternative energy sources. The Energy Agency urges the serious consideration of these bills.

In its own programs this year, the Energy Agency intends to give priority to the development and dissemination of a residential energy conservation handbook, revision and reprinting of its "Home Owners Reinsulation Guide," development of a mobile home retrofitting kit, further development of school energy management programs, and development of new conservation manuals for specific types of commercial buildings. In addition, the Agency

will participate jointly with other agencies in state building energy audits, infra-red heat loss detection programs, insulation assistance programs, energy conservation equipment testing, and seminars on energy conservation techniques.

The Future

For the future, mandatory thermal efficiency standards should be developed so that when a home is sold the new buyer is assured of an energy-efficient home. Requiring individual energy metering of apartments and commercial tenants should also be considered as part of a program to increase energy consciousness of all Minnesota residents.

In the area of building codes, prolonged or severe energy shortages could cause Minnesota to go beyond the traditional performance standards for building components or the building envelope to an "energy budget" approach, where total energy use for a building and its equipment would be restricted to a predetermined level. Other possible regulatory methods include mandatory equipment of new homes with solar heating and continued upgrading of energy efficiency standards for appliances.

Transportation

Transportation is the second largest energy using sector in Minnesota, with a consumption of 286 trillion BTU or 27 percent of the state's primary fuels and 32 percent of its net energy. Since this energy is nearly all in the form of petroleum products, transportation's role in the conservation of these scarce fuels is especially important.

Current Programs

The federal government has mandated the 55 m.p.h. speed limit, developed an energy efficiency labeling program for new automobiles, and (in the recent Energy Policy and Conservation Act, PL94-163) established higher fuel economy standards for automobiles produced in the next ten years.

The Minnesota Legislature has already passed right-turn-on-red and left-turn-on-red laws which fulfill one of the mandatory provisions of state conservation programs under PL 94-163. In addition, Minnesota is experimenting with preferential freeway access for buses and carpools on I-35W, exclusive bus lanes in downtown Minneapolis, and other ways of both improving traffic flow and promoting carpooling and mass transit.

Minnesota companies like 3M, General Mills, and Cenex have been leaders in developing the commuter van concept, and promotion of this program has been the major focus of the Energy Agency's efforts in the transportation area to date.

This Year

One area where legislation is needed this year is van pooling. More than 30 percent of Minnesota's transportation energy is used by automobiles driving from home to work. Bills to promote the use of van pools for home-to-work commuting by both state and private employees are under consideration in both houses of the Legislature. HF 1819 and SF 1752 would provide tax incentives for private employers who start commuter van programs, while HF 1382 and SF 1673 would allow the state to buy such vans for the use of its employees on a reimbursement basis.

Freight transportation uses 14.5 percent of Minnesota's transportation energy. Good freight transportation is vital to the economic health of most Minnesota communities. The railroad branchline assistance bill under consideration in the House (HF 1876) could provide a way to preserve and upgrade railroad branch lines where the volume of traffic makes them economically viable and energy efficient. Preservation of the rail alternative could reduce the number of highways which must be engineered for the heaviest trucks. This could save both energy and money otherwise needed for rural highway construction and maintenance.

Administrative action to bring about better observance of the 55 m.p.h. speed limit is another energy conservation priority for this year in the transportation sector. Through increased or innovative enforcement activities, other states have shown how this can be done. For example, Massachusetts helped local communities secure money from the federal Law Enforcement Assistance Administration (LEAA) for the purchase of additional police cars to enforce the speed limit. Other possible techniques include a strong promotional effort, the marking of state owned vehicles with "Drive 55" slogans and dashboard notices, etc.

State administrative action can also save more transportation energy through the expanded promotion with incentives of car pooling by state employees, promulgation of regulations reducing excessive highway lighting, and stronger policies favoring state purchasing of energy-efficient vehicles.

The Future

In the next few years other innovative mass transit, para-transit and ride sharing proposals must be considered for implementation, with the goal of maximizing the use of the most energy efficient transportation systems at a cost the state can afford. Appropriate incentives for energy-conserving modes of travel and disincentives for inefficient vehicles or excessive travel need to be studied if such a policy is to succeed.

Minnesota must also consider land use planning which minimizes urban sprawl and promotes non-mechanized means of travel, use of electrically powered cars for local commuting, and increased use of communication as a substitute for travel.

The federal government has to a large extent preempted the long range transportation planning area through its control over rail, bus, truck, air, barge, and pipeline companies. The states must fit into an overall national pattern, which has evolved in an environment where joint planning was not done. Only the development of a national transportation plan can resolve conflicts among transport modes in the most energy efficient way.

Industry

Industry used 20 percent of Minnesota's primary fuels in 1974 and 45 percent of its electricity. Net energy use by this sector totaled 254 trillion BTU or 28 percent of the state's total. Half this energy came from natural gas, a fuel from which more and more industries are being curtailed.

Current Programs

The Federal Energy Administration has been conducting a voluntary energy conservation program involving ten key industries with high energy consumption. Several of these industries, including food products, paper, glass, and primary metals are also among the major energy users in Minnesota. The iron ore and taconite mining industry, which uses nearly six percent of Minnesota's gross energy, is also an obvious priority for industrial energy conservation.

Many industrial energy users are already taking action to conserve energy in response to the economic incentive of higher fuel prices and reduced availability of traditional fuels. Minnesota companies like 3M, Honeywell, General Mills, Control Data, Owatonna Tool and Peerless Chain are leaders in developing comprehensive energy management programs. 3M, for example, has audited all gas-using equipment in its U.S. plants, defined process options, and estimated the investment costs for alternative fuel conversion. Several taconite companies are installing equipment which will save over 32 percent of the energy needed for heat treatment of taconite pellets. The major problem is the shortage of capital for investments related to energy efficiency or energy conservation, and the lack of a national program involving loan guarantees or tax credits.

This Year

The development of techniques for spreading the results generated by the large companies to smaller firms will be a major element of the Energy Agency conservation program. This will be done through a series of energy audits and the dissemination of an industrial energy conservation handbook.

The agency also plans to develop a program which parallels the federal program directed toward the most energy intensive industries. This program will be able to use the better portions of the corresponding federal program.

In the area of legislation, proposed legislation for tax incentive at either the federal or state level should be examined to determine its value in promoting either energy conservation or alternative energy supply investments.

The Future

Industrial conservation programs oriented toward building energy use will follow the same pattern as in the commercial area, e.g. energy audits and mandatory thermal efficiency standards. Industrial process conservation will be a product of economic incentives and information programs with the agency acting as a catalyst to start programs and keep them moving. In the future the agency will seek to develop more specific programs oriented to the needs of individual industries.

Agriculture

On-farm agricultural operations use nearly 4 percent of Minnesota's energy, mainly for field operations, crop drying and irrigation.

It should be noted that this sector is usually not reported separately in the historical energy data which exist. Gasoline and diesel fuel are usually included with the transportation sector. Other fuels and electricity are usually counted as residential if the quantities are small or commercial or industrial if they are large.

Current Programs

In response to economic pressures as well as energy concerns, many farmers are already employing energy conserving techniques. Reduced tillage, more careful application of fertilizers, herbicides, and pesticides, and more precise control over irrigation and crop drying are among the ways more and more farmers are conserving energy. Substitution of solar energy for fossil fuels or electricity in crop drying has already been demonstrated, as has production of methane gas from animal manures.

This Year

Through the formation of an agricultural energy conservation task force, the Energy Agency will seek to monitor and support these on-going developments so that the energy required to support this vital sector of our economy can be minimized. Study will also be given to how insulation of farm buildings and agricultural use of solar energy can best be promoted.

The Future

Agricultural energy conservation has traditionally been the responsibility of the agricultural extension services and the Universities. This continues to be the focus of the federal programs. The agency will work with these agencies to bring about the experimentation which is required to develop new energy conserving techniques.

Electricity Generation

Electricity generation requires 25 percent of Minnesota's primary fuels, but only one third of this energy reaches the ultimate consumers in the form of electricity. The rest is usually dissipated into the air or into bodies of water as waste heat. Making the maximum use of this heat must be a major focus of Minnesota's energy conservation plan.

Another major aspect of electric utility operations is the load factor problem. Most utilities must produce significantly more power during certain times of the day or year than others. For these short periods of time they use expensive "peaking" plants, which usually burn oil or natural gas. To decrease utility requirements for these scarce fuels and increase the efficiency of operation of base-load coal and nuclear plants, techniques must be pursued which will help level this load.

Current Programs

Northern States Power is demonstrating the use of waste heat for greenhouse operations, as described in "Alternative Energy Sources". Other uses under study by some utilities include industrial process steam and residential and commercial district heating.

The Federal Energy Administration's Utility Conservation Action Now (UCAN) program is designed to secure voluntary action by utilities to improve capacity and load factors, increase the use of less scarce fuels such as coal and nuclear, and improve the end-use efficiency of electricity consumption by at least ten percent.

Peak load pricing - that is, setting a higher rate for electricity used during the daily peak than at other times - is one major way of improving load factors. The Energy Agency intervened before the Public Service Commission in its recent NSP rate case seeking full study and partial implementation of peak load pricing. Although the PSC chose not to implement peak load pricing at this time, it ordered that a comprehensive study of the issue be carried out under its supervision. That study is now underway.

The Future

Serious consideration must be given to incentives or regulatory techniques to increase the use of power plant waste heat and to improve utility load factors. Either peak load pricing, interruptible electricity sales, or some other new type of rate will probably be necessary to maximize efficiency and minimize the use of scarce fuels for electricity generation.

III. PROGRAMS OF THE MINNESOTA ENERGY AGENCY

Since its creation on March 29, 1974, the Energy Agency has undertaken programs in a number of areas authorized or directed by its enabling legislation. Some of these programs have been facilitated by federal or other special grants, including $418,300 from the Federal Energy Administration for various fuel allocation and energy conservation programs, $270,000 from the Upper Great Lakes Regional Commission to develop a Regional Energy Information System, and $19,900 from the Upper Mississippi River Basin Commission to investigate energy/water resource relationships.

The following table lists the activity areas into which Agency programs are grouped for organizational and budget purposes, together with their current activity managers, staff complements, and operating budgets. A description of each activity is given in the sections that follow. Readers desiring further information may contact the director or the appropriate activity managers.

MINNESOTA ENERGY AGENCY FISCAL 1976 ACTIVITY STRUCTURE AND OPERATING BUDGET AS OF JANUARY 1976

Activity & Manager	State-funded staff Complement	State Appropriation: Salaries (1)	State Appropriation: Supplies & Expenses	State Appropriation: Total	% of State Approp.	Federal and other Grants	Total Budgeted Funds	% of Agency Total
Conservation John D. Peterson	6	95,800	7,445	103,245	13.2	150,408	253,653	23.2
Education Programs Rosalie L. Butler	3	33,845	5,936	39,781	5.1	897	40,678	3.7
Certificate of Need Richard A. Wallen	4	54,130	58,669 (2)	112,799	14.5	---	112,799	10.3
Project Mgmt./Info. Systems Ronald D. Visness	2	28,000	41,800	69,800	9.0	127,563	197,363	18.0
Forecasting/Impact Analyst Ernesto C. Venegas	1½	48,530	40,550	89,080	11.4	5,897	94,977	8.7
Research James E. Carter	1½	31,945	6,800	38,745	5.0	25,955	64,700	5.9
Local Services Dixie L. Diehl	6	84,084	15,180	99,264	12.7	---	99,264	9.1
Admin. Support Rudolf A. Brynolfson	6½	135,572	91,149 (3)	226,721	29.1	4,593	231,314	21.1
TOTAL	30½	511,906	267,529	779,435	100.0	315,313	1,094,748	100.0

1. Salary totals which appear high in relation to the current staff complement usually reflect higher staffing levels which existed the first half of the fiscal year.

2. The total for Certificate of Need supplies and expenses includes $51,650 diverted from other activity accounts to cover hearing costs until the Legislature can consider a $121,000 deficiency appropriation request for the operation of this program.

3. Administrative Support totals include all office space rental, copier costs, and office supply expenses for the Agency, as well as legal costs, library operation, fiscal services, and other overhead costs.

LOCAL SERVICES

The Local Services activity of the Energy Agency (formerly the Fuel Allocation Division) was established to administer the Federal Mandatory Petroleum Allocation Program in Minnesota. The Local Services staff also is responsible for organizing the state's initial response to local energy emergencies, responding to telephone queries, answering letters seeking general information, and coordinating energy-related consumer assistance programs with the Welfare Department and the Division of Emergency Services. As time allows, Local Services staff members also work on conservation programs, research projects, and other Agency activities. The Federal Mandatory Petroleum Allocation Program was established in November, 1973, in response to dwindling domestic supplies of crude oil and the Arab oil embargo. The purpose of the program was to conserve scarce energy supplies, to ensure fair and efficient distribution, to maintain fair and reasonable consumer prices, to promote the expansion of readily usable energy sources and to assist in developing policy and plans to meet the energy needs of the nation.

The allocation program established pricing regulations for both crude oil and refined products. It set certain cost pass-throughs from the refiner to the retailer, and established a profit margin base for all retailers and wholesalers. The year 1972 was established as the base period for allocating most petroleum products.

Every customer served by an oil company in the base year is entitled to receive a continued supply or allocation. Under the allocation program rules an industry, school, hospital, jobber, or

retail outlet can apply to the Federal Energy Administration to increase its monthly allotment of petroleum products.

The crude oil entitlements program was added to the allocation program in 1974. Under this program refiners owning large amounts of low-priced "old" oil have to buy entitlements from refiners dependent on higher priced imported crude or new oil. The goal is to equalize crude oil prices. The entitlements program has helped Minnesota area refiners, which are heavily dependent on imported Canadian crude oil, remain competitive.

The allocation program also provides for each state to set aside a portion of the petroleum products allocated to it to alleviate product shortages. Under this program each oil company which supplies product to Minnesota each month must set aside 3 percent of its shipments into the state of propane, gasoline, and residual fuel, and 4 percent of its shipments of diesel fuel, heating oils, and kerosene. The Local Services staff distributes these products in case of a short supply. Each oil company is required to report projected shipments, the amount certified for agriculture and space heating, the volume of products needed to supply everyone at 100 percent of allocation, and the actual volume sold in the preceding month. These reports are used by the FEA and the state to operate the set-aside program.

During 1975 the Local Services staff allocated 28,703,117 gallons of petroleum products from the state set-aside program. This represented a retail value (without taxes) of nearly $11 million and provided $1.3 million each in state gasoline taxes and oil dealer profits.

These products were allocated to 2,136 consumers, including:

Schools	19	Public Utilities	9
Apartment Complexes	5	Industries & Businesses	203
Hospitals	3	Units of Government	20
Farmers	211	Oil Jobbers	961
Truck Stops	129	Service Stations	576

The division also assisted 814 businesses and individuals in securing a permanent or increased energy supply.

The Energy Policy and Conservation Act, passed in late 1975, extended the allocation program for 40 months but could create some sweeping changes in the existing regulations. The new act directs the FEA to present a new set of regulations to Congress for approval within 120 days from the President's signing of the act on December 22, 1975. The Administration has expressed a desire to reduce the amount of regulation in the petroleum allocation and pricing area.

The purpose of the allocation program was to allocate product during a shortage which appeared acute at the time of the OPEC oil embargo. Since the fall of 1974 the anticipated shortage has not materialized and the fuel allocation activity has declined. The allocation staff has been reduced sharply, allocation officers have been used in other agency programs and the division has been reshaped into a local services activity.

The objective is to maintain the state's capacity to respond to an energy emergency while the allocation personnel are used constructively in other agency programs.

CONSERVATION

The Conservation section has undertaken a number of activities aimed at helping the people, businesses, and industries of Minnesota to use energy more efficiently

In the residential sector, the section has published a fact sheet on home insulation and answered numerous citizen questions about home insulation and household energy use. Work is continuing on a residential energy conservation handbook.

Technical services and advice have been given to agencies and utilities carrying out insulation programs. Quality control standards are being developed for foam insulation. Related studies by federal agencies, the University of Minnesota and private companies are continually monitored.

In the commercial and public buildings sector, the conservation section has published an "Energy Management Guide for Commercial Buildings." The agency is carrying out two FEA grant projects -- one for $121,000 to develop and document techniques for conducting energy audits in school buildings and the other for $40,000 to analyze the relative accuracy of seven different computer programs for simulating building energy use. The conservation staff assisted the Building Owners and Managers Association (BOMA) in a survey of building energy use for an FEA computer analysis.

Training programs have been sponsored by the section, including boiler seminars for school boiler operators and vocational school courses in energy management. Energy audits of hospitals and state buildings have been performed and plans are being developed to expand energy audits into the industrial area.

The section has worked with the State Building Codes Division to develop energy efficiency standards for incorporation into the state building code. These standards, promulgated Aug. 1, 1975, become effective January 30, 1976. A grant from the U.S. Energy Research and Development Administration (ERDA) is expected to provide $170,500 in the next two years for a demonstration program to orient local inspectors to the new code.

In transportation, the section has promoted the use of employee commuter van programs. A handbook, "Give Your Employees A Commuting AdVANtage", was sent to the 250 largest employers along with a letter supporting van pooling from Gov. Wendell Anderson. Seminars have shown interested employers how to initiate a program. Since work started on this program, four new firms in the Twin Cities metro area have installed van programs, and others are considering doing so.

State purchasing policies as they relate to energy use have been another focus of the Conservation section. A series of meetings were held with the Department of Administration and procurement personnel of the Department of Highways, Department of Natural Resources, and the University of Minnesota Transportation Services. The Division of Procurement, Department of Administration, has established an advisory standards committee with Energy Agency participation to review current procurement standards. The major function of the committee is to promote standards which meet the needs of the department while minimizing energy requirements.

The Conservation section has worked with the Minnesota Department of Highways to establish highway lighting efficiency standards. The establishment of state standards is complicated

and restricted by the existence of federal standards for federally financed highways. In almost all cases lighting levels are negotiated between the state and federal agencies so that the setting of uniform lighting standards is difficult.

A study of this problem including recommendations for resolving some of the state-federal conflicts is in process and will be completed by April 30, 1976. At that time the Department of Highways and the Energy Agency plan to promulgate state highway lighting standards that satisfy safety and illuminating requirements for both state and federally controlled highways.

An investigation of utility promotional practices was instituted by the conservation section in late 1974 and early 1975. This investigation was started because of the legislation allowing the agency to investigate and promulgate regulations limiting promotional practices.

The investigation by the agency has uncovered difficulties in the promulgation of regulations in this area.

In recent years most large utilities have emphasized energy conservation rather than the promotion of energy use. Some ads of a promotional nature are in national magazines or on national television programs seen in Minnesota. An effort to restrict this advertising would run into First Amendment problems.

Another problem is that the promotional practices of retail appliance stores do not come under the new act because these sellers are not energy suppliers.

It appears the best method to limit demand may not be to oppose promotional practices, but to limit consumer demand through other programs.

EDUCATION PROGRAMS

The act that established the Minnesota Energy Agency directs the agency to inform and educate the public on the ways in which persons can conserve energy. Education programs to encourage energy conservation and the more efficient use of energy are important if the agency is to accomplish its goal. Education in alternative energy sources also helps the public evaluate the debate on new or unconventional energy sources.

The main thrust of the agency's education activities is its effort to form a public-private group to promote energy education.

Working with the Department of Education, the agency co-sponsored a two-day workshop on December 4 and 5, 1974, which brought together 35 people representing industry, educators, environmentalists, labor, and government to consider the development of comprehensive energy education curriculum for kindergarten through 12th grade for Minnesota schools.

Bringing this diverse group together in a working session encouraged an attitude of cooperation and confidence. Since the energy situation has a tremendous impact both on the environment and on the economic health of the country, we felt it important to have the input and respect of all segments of the community. A comprehensive approach to energy education will ensure public decisions on energy issues made with wisdom and knowledge, and not through ignorance.

The seminar participants formed a non-profit organization, Energy Education, Inc., with a board of directors representing many segments of the public. The organization will solicit public and private funds for the development of energy education units, teacher motivation and training sessions, and energy education seminars to support these activities. A major fund-raising effort will begin in early 1976.

The current work of the Agency and the board is to review existing energy education curriculums. There are a number of such programs existing in the U.S. It is hoped that these can be adapted for use in Minnesota. The goal is to have trial materials in both public and private classrooms by 1976 and increased state-wide education on energy subjects by 1977.

The Board of Directors of Energy Education, Inc., the Energy Agency, and the Department of Education are working together to develop a package of energy education materials that meets these objectives.

Another responsibility of the education section is to promote public education on energy through public appearances, TV and radio interviews, participation in seminars, response to correspondence, and other public contacts. This is a continuing program in which personnel of the agency will use the public forum whenever the situation warrants.

The education section is working to assist local units of government to develop practical energy conservation programs. The agency has prepared a draft booklet listing activities and conservation programs that can be implemented by local government

officials. This document will be distributed to community leaders when it is finished. Contact with local units of government is a continuing liaison effort which will increase in importance and activity.

CERTIFICATE OF NEED PROGRAM

The energy facility evaluation staff administers the new Certificate of Need program. (Minn. Stat. 116H.13.) The purpose of the program is to insure that large energy facilities built in Minnesota truly are needed and to examine alternatives to each proposed facility.

The types of facilities which require certificates of need are electrical generating plants, high voltage transmission lines, coal storage and transshipment facilities, oil storage facilities, oil and gas pipelines, coal gasification plants, liquefied natural gas storage facilities, underground natural gas storage, and refineries.

Rules and regulations governing the certification process, both rules of procedure and rules governing the content of applications for large electrical generating facilities and high voltage transmission lines, were promulgated by September 1975. Rules and regulations for the remaining facility types must be promulgated by July, 1976.

To date the agency has received four applications under these rules:

1. United Power Association (UPA) and Cooperative Power Association (CPA) for a high voltage, direct current transmission line from Coal Creek, N.D., to Delano, Minn.

2. Northern States Power Co. for a 1600 megawatt generating facility near Becker, Minnesota (Sherburne County units #3 and #4)

3. Northern States Power Co. and Minnesota Power and Light Co. for a high voltage alternating current transmission line from Winnipeg, Manitoba, to the Twin Cities

4. Minnesota Power and Light Co. for a 500 megawatt addition to the Clay Boswell facility near Cohasset, Minn.

It is anticipated that at least three more applications will be received by June 30, 1976, two for generating facilities and one for a transmission line. Once the program is fully established, the agency expects to receive 12 to 15 applications per year.

As applications are received they are examined for compliance with the rules and regulations, and, if necessary, the applicant is required to correct any deficiencies found by the Agency. After a thorough analysis of the contents of the application, agency staff may write a report which discusses the substantive issues which it believes should be brought out at the public hearing. The agency also investigates the existence of any reasonable alternatives to the proposed facility.

Public hearings are required on each application. Hearing length will vary depending on the amount of interest shown by the public and the number and complexity of the issues raised. The first hearing on the proposed UPA/CPA transmission line started on December 8, 1975, and lasted 14 hearing days. The agency must participate in all hearings. As a party to the hearing, the agency can call its own witnesses, cross-examine other witnesses, and file a brief in support of its findings with the hearing examiner. The agency is required to keep an official record of all proceedings and correspondence relating to an application. A file index implemented as a computerized database has been developed to meet this requirement. This database will make it easy to locate information at a later date, as it can be used to isolate the reference to single documents.

The Certificate of Need program pays for itself through fees collected from the applicants. These fees, limited to a maximum of $50,000 for each application, are paid directly to the state treasury and not to the agency. Therefore, during fiscal years 1976 and 1977, the Certificate of Need program will need to be financed by deficit legislative appropriations or transfers from the Legislative Advisory Committee. In the future the full cost of the program will be included in the agency's regular biennial budgets.

RESEARCH

The goal of the Research section is to produce information which is of use to decision makers and planners, since energy awareness and energy impact will become an increasingly important part of their work. To achieve this goal, the section initiated major programs in three areas; economic/energy analysis, information system development, and energy use studies.

The section has successfully met its objectives to develop the necessary tools. The Agency now has in place:

1. An Economic Input/Output model which relates energy to the state's economy.
2. A Regional Energy Information System (Appendix A) which contains data on utilities and petroleum suppliers. The Information System project is not yet complete, but it has met its schedule deadlines.
3. Several papers describing and projecting the use of energy by specific sectors in the economy:
    a. Residential/commercial - draft stage.
    b. Manufacturing - completed.
    c. Petroleum refining - draft stage.
    d. Iron ore and taconite mining - completed.
    e. Agriculture - completed.
    f. Electric utility - draft stage.
    g. Transportation - draft stage.

Besides these three major efforts, the Research Section has also acted to respond to technical information requests, and to prepare testimony for various federal and state hearings.

In the recent Agency reorganization, economic modeling and information systems were established as separate activities. The Research section was given a new responsibility to develop Agency policy in the areas of coal development and alternate energy sources. Work in this area will orient the Research section toward long-range solutions to energy supply problems. This reorientation is relatively new so work programs and specific projects are still in the planning stage. It appears that the priority items must be:

1. Minnesota's bid to the Energy Research and Development Agency (ERDA) for the national Solar Energy Research Institute (SERI), due early in 1976.

2. Development of alternative strategies for coal use in Minnesota.

3. Evaluation of peat as a primary energy resource.

The Research section has been and will continue to be that part of the Agency responsible for initiating new directions. Its goal is to develop an overall incremental energy supply plan for Minnesota.

FORECASTING AND IMPACT ANALYSIS

A major effort of the Agency has been to relate energy requirements to the state's economy, recognizing the close relationship between economic growth and energy consumption. The possibility of energy shortages also creates a need for a method which will yield the optimum allocation of available energy supplies. The Minnesota Trade-Off Model (MINTOM) was built to explore both of these issues.

MINTOM is an Input/Output (I/O) model that uses purchases and sales between sectors to describe the structure of the economy. Previous studies have shown that the basic structure of an economy changes slowly and that only substantial new industry affects the purchase and sale pattern. This stability allows the use of an I/O model for both projection and optimization studies.

The model is augmented by primary inputs (labor, value added, imports), and final demands (household purchases, capital formation and inventory change, government purchases, and exports). It is possible to trace the effect of a change in final demand by allowing the demand to ripple through the economy. Projections are done by varying both inputs and final demands and observing the effect on the economy described by the model.

The basic I/O model also has been augmented by energy, environmental, and fiscal impacts. The energy data is a coefficient for BTU per dollar of production in each producing sector. An example of an environmental coefficient is the pounds of the pollutant sulfur dioxide per dollar of production. These additional coefficients

correlate energy and environmental impacts with economic activity, and allow the Agency to project total energy use.

The model also can be reformulated into a linear program for optimization studies; for example, to determine how to minimize unemployment under a 15 percent reduction in energy supplies. In I/O models optimization capability forms the basis for possible allocation procedures in a time of shortage. The effect of a major structural change, such as the closing of one or more refineries, also can be measured using the impact analysis section of the model.

The basic models are complete but much work needs to be done to refine estimates and to validate the results of projections. Two of the major remaining efforts are:

1. To refine the estimates which relate energy use to production level and employment.

2. To develop state control totals for energy use which cross-check with other state agencies and the federal government.

The development of the I/O model is in a sense a capital investment by the Agency. The development of the model will allow the Agency to put more depth into its analysis of the complex interrelationships among energy, environmental and economic activities. The Minnesota Trade-Off Model will become a primary policy tool of the Energy Agency. The capability to evaluate the impact of energy decisions on the state's economy will make MINTOM an important aid to decision makers.

IV. APPENDIX A

REGIONAL ENERGY INFORMATION SYSTEM

Background

When the full impact of the energy crisis hit the United States in late 1973, many states found they did not have adequate knowledge or resources to cope with the problems in their area. Governors, legislators, and state agency heads found they had great difficulty answering even the simplest questions of who supplies what, where, when and how. Although some writers had predicted future shortages, most public officials had taken energy for granted, particularly energy derived from petroleum resources.

The Arab oil embargo led many states to move quickly to establish energy or fuel coordination offices often within their civil defense departments. The first job of these new offices was to allocate gasoline, fuel oil, and propane to keep the economy moving. After the crisis period, some state officials continued to worry about longer-term problems.

In Minnesota, the Division of Emergency Services took the lead in creating two new tools - one to analyze the impact of energy problems on the economy of the state and the other the impact on the Upper Great Lakes region. The Upper Great Lakes Regional Commission funded a project to develop a regional energy information system (REIS) and a regional input-output economic model for northeastern Minnesota. Work on these two related projects, having been transferred to the Energy

Agency along with fuel allocation responsibilities, was begun in the summer of 1974.

Description of the REIS System

The REIS system uses the computer facilities at the University of Minnesota. These include a large Control Data Cyber 74 computer system and a programming language called SYSTEM 2000. The data collected have been organized into a database which can be used for periodic reports and for direct queries using a computer terminal

Overall responsibility for the REIS project rests with Dr. James Carter, Director of Research, Minnesota Energy Agency. Dr. Norman Chervany from the University of Minnesota College of Business is principal investigator for the information systems part of the project, and Dr. Wilbur Maki from the University of Minnesota Department of Agricultural and Applied Economics is responsible for the economic modeling. The original goal was to coordinate the two parts of the project so that the data developed as part of the information system work could be used as input data to the economic model.

During the first phase of the information systems project, the investigators decided that designing for statewide data collection was more practical than designing for regional data collection. Therefore, collection procedures were built for statewide collection of data on a county-by-county basis.

The system is designed to collect two types of data: (1) "identification data" which describes those firms which supply energy to the area and (2) "flow data" which reports the flow of energy from suppliers to distributors or consumers. In addition to describing new suppliers of energy, identification data also consist of historical data on past flows of energy as reported to other agencies (e.g., the Federal Power Commission).

The agency began to collect identification data from electric and natural gas utilities in August, 1975, and from petroleum companies in October, 1975. Most of the identification data collected thus far have been inserted into the REIS database. The Agency staff currently is working to validate the data by correcting errors and inconsistencies.

The agency has found that the data collected in this first effort are not as accurate as desired. Therefore, the agency has created a series of reports which it will send to the utilities for the purpose of data correction. The use of a turn-around report will insure that the data contained within the REIS system will be current and as accurate as possible. The turn-around method will be used in future years to ease the reporting burden on the suppliers and the keypunching burden on the state.

Energy flow data will be collected from electric utilities, natural gas utilities, natural gas pipeline companies and petroleum companies beginning in April, 1976. Electric utilities will report monthly kilowatt hours consumed by customer class and by county. The method of customer classification will be the standard industrial codes (SIC) which are used in almost

all economic work. The geographic region chosen for use is the county. The same type of data will be collected from natural gas utilities except that the basic unit of measure will be thousands of cubic feet of gas consumed.

Petroleum companies will report each truck load of a product moved out of a major petroleum terminal. The bill of lading used as the source document for petroleum companies' reports to the Petroleum Tax Division of the Revenue Department will be used as the flow data record for petroleum products. The use of the bill of lading means there is no basic reporting period (e.g., daily, weekly, monthly, etc.) for petroleum products but the REIS system will have the capability to change between daily, weekly, or monthly reporting periods.

The normal operating procedure will be monthly so that all bills of lading for a month will be batched before they are entered into the REIS system. In times of emergency it will be possible to enter bills of lading into the REIS system almost as soon as they are generated at the petroleum terminal.

The ability to change operations as requirements change is one of the needed flexibilities that has been designed into the REIS system. It is expected that by June 30, 1976, the energy flow data portion of the REIS system will be fully operational.

Examples of REIS Output

Example 1: Turnaround Report

The turnaround report is a printout of data contained in the database.

This report is produced using the report writer features in the SYSTEM 2000 Language. The report will serve two purposes:

First, it will allow the agency to obtain information from the database in a form similar to traditional reports. The report may be used for information purposes or to compare it with later data from other sources. Utilities and other data sources can check the accuracy of the database. Corrections can be written directly on the report.

Secondly, the report can be used by utilities in the preparation of their annual data report to the agency. They will be able simply to indicate changes from the prior year's data. This will simplify the utility reports and ease the burden on both the utilities and the agency.

The report writer feature will be used for the reports which require description interpretation or analysis. An example of the Turnaround Report is shown below.

♦♦♦♦♦♦♦♦
MEA-1101 UTILITY REGISTRATION FORM MEA DOC NO 1
♦♦♦♦♦♦♦♦

INFORMATION DISPLAYED WAS RECEIVED BEFORE DEC 31, 1975 AND IS RETURNED FOR REVIEW. PLEASE LINE OUT ERRORS AND GIVE CORRECTIONS. ADD MISSING INFORMATION. RETURN BEFORE JULY 1,1976.

NAME OF FIRM		TYPE	FPC NO	BOM NO
? AGRALITE COOPERATIVE		? COOP	? UNKNOWN	?
STREET			FEA NO	MN LIC NO
? EAST HIGHWAY 12			?	?
CITY	STATE ZIP			
? BENSON	? MN ? 56215			
COUNTY	E.I.N.			
? SWIFT	? 41-056-0428			

NAME AND ADDRESS OF OWNER(S)
?
STREET
?
CITY STATE ZIP
? ? ?

1

PERSONS AVAILABLE FOR CONTACT	CONTACTS' TITLES	TELEPHONE
? DONALD ANFINSON	? OFFICE MANAGER	? 842-6711 EX7
? HAROLD JOHNSON	? LINE SUPERINTENDENT	? 842-6711 EX6
? VINCENT GALLAGHER	? ASSISTANT MANAGER	? 842-6711 EX4
? WILLARD ANDERSON	? MANAGER	? 842-6711 EX3
?	?	?

1

♦♦♦♦♦♦♦♦
MEA-1102 FEDERAL FORMS LIST MEA DOC NO 1
♦♦♦♦♦♦♦♦

NAME OF FIRM
AGRALITE COOPERATIVE

ISSUING AGENCY	FORM NUMBER	FORM TITLE	CYCLE
? FPC	? 12A	? POWER SYSTEM STATEMENT	? YRLY
? REA	? 7	? FINANCIAL & STATISTICAL R	? MNTHLY
? REA	? REA 12F	? OP REPORT - INT. COMB. PL	? MNTHLY
? REA	? 7A	? SUPP TO FINANC & STAT RPT	? YRLY
?	?	?	?

1

♦♦♦ ♦♦♦♦♦ ♦♦♦ ♦♦♦♦♦
FPC 12-10 OR BOM 1340A: END USES MEA DOC NO 1
♦♦♦ ♦♦♦♦♦ ♦♦♦ ♦♦♦♦♦

NAME OF FIRM
AGRALITE COOPERATIVE

YEAR	FARM	IRRIGATION	RESIDENTIAL	COMMERCIAL	INDUSTRIAL
65	32,561,789	0	329,733	510,560	647,728
66	35,768,464	0	331,590	441,870	1,287,605
67	37,945,698	0	435,306	399,810	1,460,730
68	40,222,724	0	521,160	338,180	1,442,264
69	42,407,583	204,000	588,090	407,550	1,701,426
70	45,264,440	353,150	621,920	421,990	1,349,960
71	1,029,677	614,550	47,593,766	364,504	1,302,260
72	50,430,455	303,237	1,039,556	434,162	1,470,740
73	50,745,398	663,850	1,051,218	444,674	1,636,740
74	53,792,302	1,202,780	1,170,536	497,380	2,015,350

END SYSTEM 2000

Example 2: Use of the System 2000 LIST command. The LIST command is a flexible tool which can be used to produce simple reports. The data can be presented in columns with each colum titled. The command shown is in English.

> Write a list suppressing all repeating data items. The list will include company name, name of contact person and his phone number. The list should be alphabetically ordered by company name. The list should include only those utilities defined as coops.

```
* LIST/REPEAT SUP/C2,C3,C41,OB C2 WH C8 EQ'COOP:
```

The LIST command creates a report which sometimes splits words in strange places so that the final reports may look rather untidy. However, it does contain the data as it exists in the database.

```
ESTABLISHMENT                  INFORMANT          INFORMANT PHONE
***
AGRALITE COOPERATIVE           WILLARD ANDERSO    842-6711 EX3
                               N
                               DONALD ANFINSON    842-6711 EX7
                               HAROLD JOHNSON     842-6711 EX6
                               VINCENT GALLAGH    842-6711 EX4
                               ER
ARROWHEAD ELECTRIC COOPER      E L SIMON          663-7230
ATIVE
BELTRAMI ELECTRIC COOPERA      DONALD ANDERSON    7512540
TIVE
                               EARL LARSON        7512540
                               JOHN UNGER         7512540
BLUE EARTH-NICOLLET COOPE      C L PALMERSTON     387-7963
RATIVE ELECTRIC ASSN
BROWN COUNTY RURAL ELECTR      JACK HENTGES       507 794-3331
ICAL ASSOCIATION
                               AR ROSSETH         507
CARLTON COUNTY COOPERATIV      JACK A HUHTA
E POWER ASSN
                               WILLIAM
                               HEN
CLEARWATER-POLK ELECTRIC
COOPERATIVE
CROW WING COOPERA
ER & LIGHT CO
```

Example 3: Print Command. The simplest possible way to retrieve data from the database is through the use of the SYSTEM 2000 print command. This command is used to get a quick look at the data. The report is not arranged on any format. Each data item appears on a separate line. The command below illustrates the use of qualification to select data from the database. The command given in English is:

> Print utility name, street address, city, zip code and sales volume in megawatt-hours (MWH) where year equals 1974 and megawatt hour sales are equal to or greater than 5000 MWH and less than or equal to 25,000 MWH.

```
---
? PR C2,C24,C27,C38,C954 WH C980 EQ 74 AND C954 SPANS 5000:25000:
 2: AITKIN PUBLIC UTILITIES COMMISSION
 27: AITKIN
 38: 56431
      954:          16809
 2: PROCTOR PUBLIC UTILITIES COMM
 24: 222 3RD AVENUE
 27: PROCTOR
 38: 55810
      954:          11429
 2: MOOSE LAKE WATER & LIGHT COMM
 24: 401 DOUGLAS BOX 418
 27: MOOSE LAKE
 38: 55767
      954:           8497
 2: ST CHARLES LIGHT & WATER DEPT
 24: 1413 RICHLAND AVENUE
 27: ST CHARLES
 38: 55972
      954:          10719
 2: KASSON CITY OF
 24: 112 WEST MAIN ST
 27: KASSON
 38: 55944
      954:           5905
 2: NASHWAUK WATER LIGHT POWER & BUILDING
 24: CENTRAL AVENUE
 27: NASHWAUK
 38: 55769
      954:           5754
---
```

APPENDIX B

MINNESOTA ENERGY EMERGENCY PLAN

Emergency Plan Development

The development of a Minnesota Energy Emergency Conservation and Allocation Plan was directed by the legislature in the act creating the Minnesota Energy Agency (Minn. Stat. 116H.09). The plan is intended to be executed with the onset of a shortage in any one of the six basic energy supplies -- electricity, fuel oil, natural gas, propane, coal, or gasoline.

Almost four thousand copies of the first draft of the plan were distributed in late 1974 to energy producers, distributors, users, educators and legislators. In addition, 14 public meetings were held throughout the state where the views of members of the public were solicited and obtained.

The reactions from distributors, suppliers, users and others were reviewed, catalogued, and where practical incorporated into the final version of the emergency plan. The Minnesota Energy Act of 1974 stipulates that the emergency plan will be reviewed upon the completion of any major energy facility or every five years.

As stipulated in the law, the emergency plan may be activited by the Executive Council or the Legislature. The emergency thus declared cannot last for more than 30 days without a specific declaration of continuation by the Executive Council.

The Director of the Energy Agency has an advisory responsibility to the Governor and to the Legislature and he may request the declaration

of an energy emergency. The Energy Agency has the responsibility of monitoring energy supplies within the state and providing information, analyses and, recommendations to the Governor and the Legislature. The Agency also can evaluate the results of conditions which may cause emergency shortages including possible natural and man-made disasters.

Where possible, the director of the Energy Agency shall advise the Executive Council and the Legislature of the approaching emergency situation prior to the need for a declaration of an emergency. After the declaration of an energy emergency, the Director of Emergency Services will be responsible for the execution of the emergency plan.

Major Elements of the Emergency Plan

1. When an energy emergency is declared, the Director of Emergency Services immediately will assume authority to control the shortage, distribution, transportation, and resupply of energy supplies within the state. Such authority shall be used at his discretion as the emergency situation demands.

2. The Executive Council or the Legislature may declare that an energy emergency exists within limited geographic boundaries.

3. When an emergency is declared, the Emergency Services Director will assume authority to assign state employees from departments other than his own to work on assignments at locations where in his judgment they can best serve. Commissioners, Directors and administrative personnel of other state agencies are required to cooperate fully by making employees available to the Director of Emergency Services.

4. Personnel from the Department of Emergency Services will be trained in the emergency plan.

5. An appeals process has been established whereby an individual or firm which feels that it has been damaged by the execution of the plan can seek relief. The appeals process consists of two steps, the first of which is an appeal to a local board, and the second an appeal to a state board.

6. An energy emergency will be terminated by the Executive Council acting on the advice of the Director of the Energy Agency.

7. The plan is divided into four phases for each fuel source. Phase I is a supply restriction that is not so severe that it requires the use of the state's emergency police powers. Phases II, III and IV are designed for increasingly severe supply curtailments. The major actions that can be taken include public appeals to conserve energy, adjustments to thermostat settings for space and water heating, closing of public and private facilities, and load management to shift demand into more favorable time periods.

The emergency plan is now being revised in an attempt to simplify some of the wording, decrease the number of phases and combine some of the fuel types. It is intended that this revision will make the emergency plan simpler and more workable for the Director of Emergency Services.

APPENDIX C

UNITS USED TO MEASURE ENERGY

To compare energy from different fuels, a "common denominator" is needed. The customary unit in the U.S. is the BTU (British Thermal Unit). One BTU is the amount of heat required to raise one pound of water one degree Fahrenheit.

In the metric system, the unit for measuring energy is the joule. It takes about 1055 joules to equal 1 BTU. For rough estimates, however, it is sufficiently accurate to think of 1 BTU as approximately equal to 1000 joules or 1 kilojoule (KJ).

The kilowatt-hour (kwh) is another commonly used energy unit. A power level of 1 watt is an energy flow rate of 1 joule per second. One kilowatt-hour is an energy flow of 1000 watts for one hour. However, to produce one BTU of electrical energy, a steam generating plant must use about three BTU's of a primary energy source. The other two BTU's are sacrificed as conversion losses in the generating process.

One other way energy is compared is by choosing one fuel as a base and converting others to its energy equivalent. Thus, federal publications focusing on oil problems often convert total U.S. energy use into "barrels per day oil equivalent." One barrel of oil contains about 5.8 million BTU's.

In discussing energy on a state, national, or world-wide level, very large numbers are used. A number of "shorthand" ways of dealing with such numbers are shown in the following table:

Arabic Numeral	U.S. Term	Power of 10	Metric Prefix
1,000	thousand	10^3	kilo- (k)
1,000,000	million	10^6	mega- (M)
1,000,000,000	billion	10^9	giga- (G)
1,000,000,000,000	trillion	10^{12}	tera- (T)
1,000,000,000,000,000	quadrillion	10^{15}	peta- (P)
1,000,000,000,000,000,000	quintillion	10^{18}	exa- (E)

Minnesota Energy Agency publications commonly express state energy use in trillions of BTU's while Federal publications often use quadrillions of BTU's (or "quads") to describe national energy totals. Studies of worldwide energy resources sometimes use quintillions of BTU's (or "quints").

The oil and gas industry has terms and abbreviations it uses including:

bbl	barrel (42 gallons) of oil
BPD or B/D	barrels per day
MCF	thousand cubic feet of natural gas
MMCF	million cubic feet
MMcfd	million cubic feet per day
therm	100,000 BTU (or about 100 cubic feet of natural gas

The Energy Agency has developed estimates of the energy content of the major fuels used in Minnesota, as shown in the table on the next page. The notable difference from national figures is for coal where the predominate use of low-BTU western coal and lignite in Minnesota leads to lower coal figures for Minnesota than for the U.S. It must be emphasized, however, that all energy conversions for fossil fuels are approximate because of variations in the energy content of specific energy resources.

ENERGY CONTENT OF FUELS USED IN MINNESOTA

FUEL	UNIT	BTU	Kilojoules	kWh
Coal	pound	10,615	11,200	3.11
	ton	21,230,000	22,400,000	6,220
	metric ton	23,400,000	24,700,000	6,860
Natural Gas	cubic foot	1,000	1,055	0.293
	cubic meter	35,315	37,260	10.35
Crude Oil	barrel	5,800,000	6,100,000	1,700
	metric ton	41,000,000	43,000,000	12,000
Gasoline	gallon	125,000	132,000	36.6
	liter	33,000	35,000	9.7
Distillate Fuel Oil	gallon	138,690	146,300	40.6
	liter	36,600	38,700	10.7
Residual Oil	gallon	149,690	157,900	43.9
	liter	39,500	41,700	11.6
Liquefied Petroleum Gas	gallon	92,000	97,000	27.0
	liter	24,300	25,600	7.1

APPENDIX D

ENERGY AGENCY PROJECT COORDINATION AND MANAGEMENT

Introduction

The reorganization plan of the Energy Agency effective in December, 1975, is designed to create an organization with a sense of direction and the flexibility necessary to deal effectively with the current energy situation. The supervision of such an agency can be best accomplished using a management of objective (MBO) philosophy, where personnel and other resources are used to achieve stated objectives. The following is a description of the tools the agency will use in its project management/MBO program.

Project Management

The project worksheet, described below, is designed to maintain supervision of the agency and to implement the necessary management tools. This form is backed by a project control database which also is designed specifically for Energy Agency use. The project worksheet is the primary input and planning document. The data from the worksheet is entered into the database as new projects are initiated.

The database is used by the director to evaluate project progress. Reports tailored to his requirements are developed as needs arise. The development of this database is an off-shoot of the Regional Energy Information System (REIS) project and uses capabilities developed in that project.

The ability to create reports on demand means the director has the capability to review projects individually or in groups and that he can then make adjustments as required to staffing

patterns or priorities. The project worksheet/database method was chosen as one way in which control can be exercised without excessive meetings. The technique allows the agency to respond to high priority statutory requirements, crisis situations and special requests while maintaining control over longer duration projects.

The worksheet is the primary tool used for planning and evaluating projects. It is used to set priorities among projects and is, in fact, the heart of the agency's simplified management by objectives program. The data placed on this form also is stored in a database which is used to review project status and personnel assignments.

New Project Initiation

Staff members who wish to initiate new projects first complete a project worksheet (see example) according to the instructions shown below.

Instructions for Preparing Project Worksheets:

Date Prepared	Document creation date
Project Title	A short descriptive set of words which can be used in both internal and external communication.
Goal Statement	A statement of the Agency's goal or goals advanced by the project and their relationship to overall agency goals.
Project Abstract	Project objectives, work methods, tools to be used and resources required

MINNESOTA ENERGY AGENCY
PROJECT WORKSHEET

DATE PREPARED _____

PROJECT TITLE:		
PROJECT ABSTRACT:		
PROJECT MANAGER:	EXPECTED COMPLETION DATE	FUNDING SOURCE
ACCOUNTING USE:		

TASK NUMBER	TASK DESCRIPTION	RESOURCES REQUIRED	PERSON-DAY REQUIREMENT	IMPORTANT MILESTONE DATES

FORM MEA 1114 10-27-75

MINNESOTA ENERGY AGENCY
PROJECT WORKSHEET

TASK NUMBER	TASK DESCRIPTION	RESOURCES REQUIRED	PERSON-DAY REQUIREMENT	IMPORTANT MILESTONE DATES

Project Manager	The name of the responsible person
Expected Completion Date	The date when all the work proposed in the project is expected to be completed.
Funding Source	The source of the required funds, e.g. state appropriation, federal grant, etc.
Accounting Use	To be used by Administration and Finance to write in AID numbers, encumbrances, etc. if needed
Task Number	Sequential number 1 to N
Task Description	A short explanation of the work to be done. Judgment is required here as tasks which are too small (1-2 person-days) result in a complicated plan and tasks which are made too large (3-4 person-weeks) result in a loss of control. A good idea is to try to limit tasks to 1 person-week of effort.
Resources Required	People are the prime resources The Project planner should indicate what type of training or skills are required to complete the task (engineer, planner, statistician).
Person-Day Requirement	An estimate of how long it would take to complete the task assuming normal workdays and using allowances for time devoted to non-project activities (coffee breaks, consulting, problems, meetings, etc.)
Important Milestone Dates	Only those tasks which signify completion of a significant section of the work should be dated. These dates will be used to evaluate the progress of the project.
Task Sequence Diagram	This is a modification of a critical path diagram. It should show the sequential and parallel relationships of the tasks. The diagram should show the task number, task description and man-day requirement.

Project Implementation Steps

Assistant Director for Project Coordination	Review project plan with preparer and discuss project priority, staff assignments, funding and objectives. Enter the project plan into the project control database and return the project worksheet to the activity manager.
Director	Discuss project, goal and anticipated results and requirements with Assistant Directors, Activity Managers and staff. Approve or disapprove projects and set the priorities of those approved.

Project Review and Performance Evaluation

Activity Manager	Keep project worksheet current
Assistant Director	Produce a bi-weekly project list for use by Activity Managers
Activity Managers	Update project list using project worksheet: tasks which have been completed, changes to milestone dates, description of problems, and significant achievements.
Assistant Director	Review the completed project lists with the Activity Managers and update the project control database.
Assistant Director	Produce project current status report.
Director	Periodically review project status and make any necessary changes in staff assignments, funding, objectives and milestone and completion dates.

APPENDIX E

LONG TERM DEMAND PROJECTIONS

The economic forecasting section of the Agency has prepared long term demand projections which are based primarily on the growth potential of industries in Minnesota. These projections were computed using the Agency's economic Input/Output model with Minnesota's share of national market growth to estimate final demands. The forecast based on market outlook may be restrained by future higher prices and scarcities of specific fuels. The projections may also err due to new technologies which could reduce fuel requirements or allow fuel substitutions. However, the long term demand projections should be interpreted as maximum requirements under conditions of sufficient fuels, constant output to fuel price ratios, absence of deliberate conservation efforts, and a maintenance of the current economic structure.

LONG TERM DEMAND PROJECTIONS

		Primary Fuels (Coal, Natural Gas, Fuel Oil)	Transportation Fuels (Gasoline, Diesel, LPG)	Total	Electricity 109 kWh
1974	Industrial, Commercial	610.0	-----	610.0	15.0
	Residential	229.3	-----	229.3	9.3
	Transportation	-----	286.3	286.3	----
	Agriculture	-----	36.5	36.5	----
	Total	839.3	322.8	1162.1	24.3
1980	Industrial, Commercial	745.5	-----	745.5	18.4
	Residential	217.3	-----	217.3	13.7
	Transportation	-----	342.0	342.0	----
	Agriculture	-----	45.2	45.2	----
	Total	962.8	387.2	1350.0	32.1
1985	Industrial, Commercial	970.9	-----	970.9	23.9
	Residential	221.8	-----	221.8	15.7
	Transportation	-----	396.0	396.0	----
	Agriculture	-----	54.0	54.0	----
	Total	1192.7	450.0	1642.7	39.6
1990	Industrial, Commercial	1294.7	-----	1294.7	31.7
	Residential	224.4	-----	224.4	17.8
	Transportation	-----	458.5	458.5	----
	Agriculture	-----	64.5	64.5	----
	Total	1519.1	523.0	2042.1	49.5
1995	Industrial, Commercial	1726.5	-----	1726.5	42.0
	Residential	227.0	-----	337.0	20.2
	Transportation	-----	530.8	530.8	----
	Agriculture	-----	77.0	77.0	----
	Total	1953.5	607.8	2561.3	62.2
Rates of Growth (%)					
	1974-80	2.3	3.1	2.5	4.7
	1980-85	4.4	3.0	4.0	4.3
	1985-90	5.0	3.0	4.4	4.6
	1990-95	5.2	3.0	4.6	4.7

APPENDIX F

ENERGY AGENCY PUBLICATIONS, 1974-75

Consumer Information

Ceiling Reinsulation Guidelines

Energy Management for Commercial Buildings

Give Your Employees a Commuting AdVANtage:
How to Organize a Commuter Van Program

Energy in Minnesota -- General

November, 1974: Minnesota Energy Supply and Use, 1972

December, 1974: Minnesota: An Energy Importer with A Complex Web of Supply, Distribution, and End Use

January, 1975: Comments on Electricity in the Midwest, 1975

February, 1975: Minnesota Energy Use Trends, 1957-73

August, 1975: Minnesota's Energy Situation to 1985

Energy Supply/Demand Forecasting and Impact Analysis

July, 1974:	Minnesota Energy Requirements Projection Model
December, 1974:	Forecasting Energy Requirements in Minnesota
March, 1975:	Impact of President Ford's Energy and Economic Proposals on Minnesota
April, 1975:	MINTOM: Minnesota Trade-Off Model, Energy/Economy/Environment (Originally titled, "A 1972 Structural Model of the Minnesota Economy: Towards a Policy-Oriented Tool")
April, 1975:	Alternative Futures: Minnesota Natural Gas Curtailments
June, 1975:	Demand for Motor Fuel in Minnesota: Some Preliminary Results
June, 1975:	Energy Consumption in Manufacturing and the Minnesota Economy
August, 1975:	Energy Requirements in Minnesota Iron Ore and Taconite Mining, 1953-2000
August, 1975:	Estimating Procedures for Energy Requirements in Minnesota Iron Ore and Taconite Mining
October, 1975:	Energy Needs for Minnesota Agriculture Production, 1974-1985 (draft)
Draft Pending:	Effects of Natural Gas Curtailment in Minnesota, 1973-1980
Draft Pending:	Energy Use in Transportation in Minnesota
Draft Pending:	Energy Use in Minnesota Residential and Commercial Buildings, 1970-1985

Energy/Water Resources Relationships
(Funded by the Upper Mississippi River Basin Commission)

Preliminary Draft: August, 1975:	Energy in the Upper Missippi-Souris-Red-Rainy River Basin: Implications of Changing Patterns
September, 1975:	Decision-Oriented Information Base/ Part I: Historical Energy Consumption and Production Patterns
September, 1975:	Decision-Oriented Information Base/ Part II: Inventory of Known Energy Production Capacity Expansions
November, 1975:	Twin Cities Area Level B Study: First Cut Initial Plans -- Energy/Water Resources Relationship
December, 1975:	Energy Use in Water Supply of the 7-County Metropolitan Area

Programs of the Minnesota Energy Agency

December, 1974:	MEA Conservation and Planning Division: Six Months Progress Report, July 1, 1974-December 31, 1974
December, 1974:	MEA Research Division Six Months Progress Report, July 1, 1974 - December 31, 1974
December, 1974:	Proposed Residential Thermal Improvement Program for Minnesota
June, 1975:	Minnesota Energy Agency Statement of Policy, Goals and Responsibilities

Regional Energy Information System
(Funded by the Upper Great Lakes Regional Commission)

July, 1974:	Design Considerations for a Comprehensive Regional Energy Information System
August, 1974:	Master Plan for REIS Implementation
December, 1974:	State/Regional Economic Models for Long-Range Energy Planning/Working Paper, 74-03
	Northeastern Minnesota Energy Utilization Survey and Capital Expenditure Survey
December, 1975:	REIS Flow Input Specifications
January, 1975:	REIS: Phase I/Regional Energy Information System for Minnesota: A Preliminary Design
July, 1975:	REIS: Phase II/Report I: An Overview of the REIS System
October, 1975:	REIS: Phase II/Report II: The REIS Data Bases
September, 1975:	REIS: Phase II/Report IV: REIS Data Collection Procedures