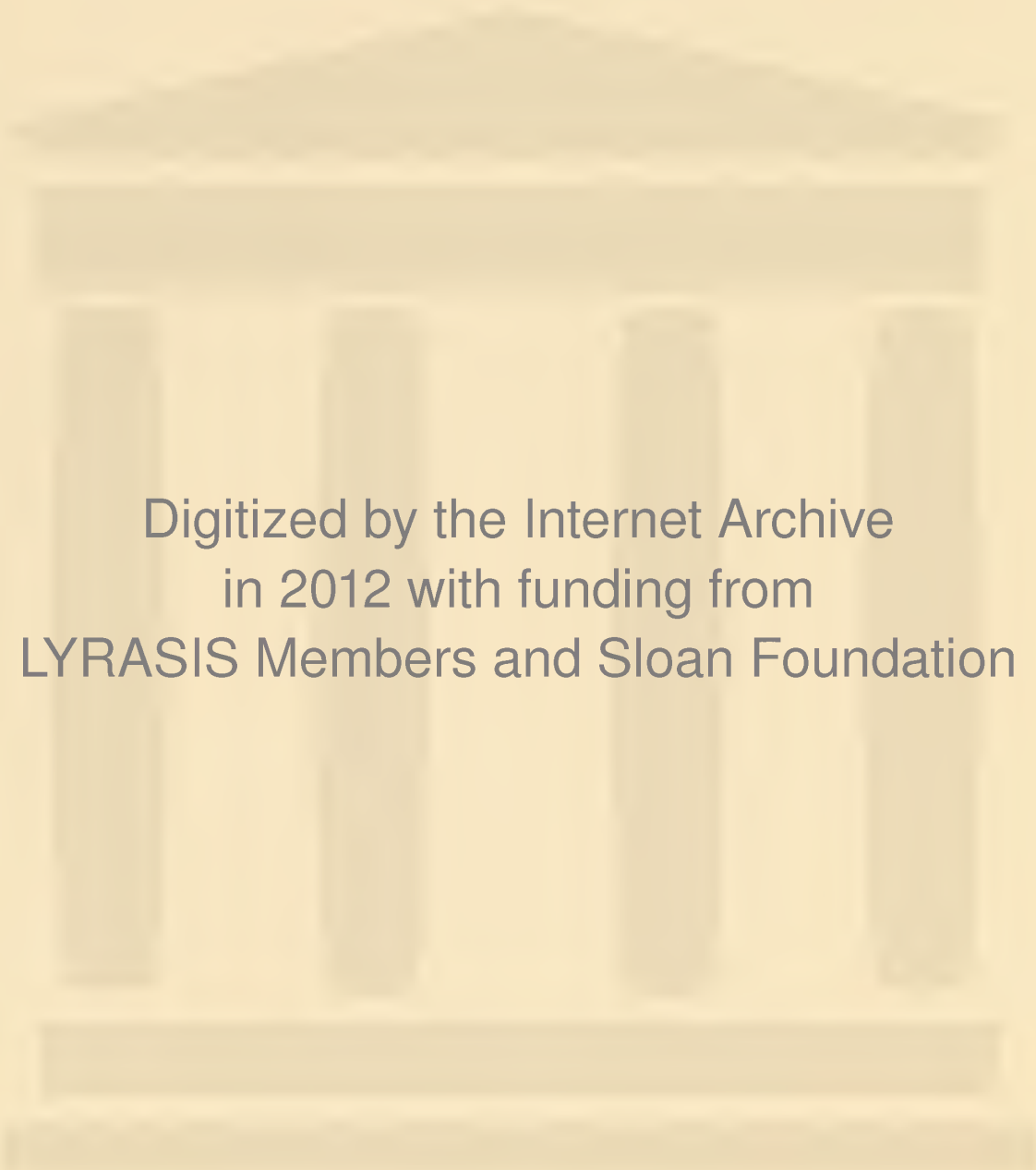

ENERGY CONSUMPTION, CONVERSION PLANS, AND CONSERVATION IN KANSAS COMMERCIAL AND INDUSTRIAL FIRMS

by

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B.A., University of Cincinnati, 1972

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1979

Approved by:

Major Professor

AKNOWLEDGMENTS

I would like to express my appreciation to the persons who provided help, encouragement, and financial assistance in the development of this study. The comments and criticisms of Professor M. Jarvin Emerson, my major professor, and Professors John A. Nordin and Krishna R. Akkina, members of my committee, were very helpful. I would like to thank the Department of Economics for their financial assistance during my years at Kansas State. In addition, I wish to thank Ms. Carmen Zopf and Ms. Sharon Hoeffner for the expert job they did of editing and typing this thesis. Many persons at the Long Island Lighting Company have provided suggestions and encouragement as well, which was greatly appreciated.

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CHAPTER I

INTRODUCTION

The Energy Problem

Early warnings of the changing energy supply situation surfaced during the winter of 1971-72, when shortages of fuel oil first occurred. Spot gasoline shortages followed during the next summer, primarily the result of inadequate refinery capacity.[1] The "oil crisis" of October, 1973, marked the beginning of an increased energy awareness in the United States. Rising fuel prices and more limited availability of certain energy sources since 1973 have posed problems for most commercial and industrial firms, and have created the need to reassess production methods. However, the re-evaluation of past production decisions and future plans has been difficult for two reasons. First, there is a great deal of uncertainty with respect to the future path of relative energy prices, fuel availability, and government policy. Second, there is a dearth of accurate information concerning energy consumption, particularly at the regional or state level. This lack of knowledge poses a problem for government policy makers and administrators, in that there is a high probability of achieving unexpected impacts on the economy when implementing energy policies.[2]

Since the oil embargo, much has been written concerning the energy crisis, but little work has been done to produce accurate consumption data on the state level, especially in a disaggregated form using Standard Industrial Classifications. Even less is known about the "end uses"[3] of energy in the commercial-industrial sector on a regional level. Conservation practices are usually approached in a piece-meal fashion, assuming that impacts are simply additive and that a short pay-back period is the major criterion for adoption. On a state basis, there is a need for assessment of the effect of an array of commonly implemented conservation measures.

The objectives of this study are to estimate energy consumption for commercial and industrial firms in Kansas during 1973 and to ascertain the reactions of the firms to the energy crisis as evidenced by increased standby fuel storage capacity, conversion to alternate fuel types, and adoption of energy saving techniques. Knowledge of the energy consumption patterns in existence at the time of the oil crisis would be a prerequisite to an analysis of the impact of decreased fuel availability on the economy of the region and to the formulation of any allocation plan based in part upon past consumption. Information concerning the energy management policies and programs, technological changes, and other adjustments already enacted in response to the energy crisis is necessary before the potential for further changes can be analyzed.

This study presents the consumption of six major fuels and electricity by twenty-three industries in Kansas during 1973. Natural gas, coal, gasoline, distillate and residual fuel oil, and liquid petroleum gas are the chief fuel types considered. Of the twenty-three industry groups, six are part of the commercial sector and seventeen are defined as industrial. The industries consuming interruptible natural gas are identified and their hours of curtailment are estimated for 1970 through 1973, and from January through May of 1974, to determine whether the frequency of interruption had increased.

Consumption of interruptible natural gas is generally associated with use of a standby fuel system, usually one which burns coal or oil. This study gives, for each industry, the types of standby fuels used, and their storage capacities in physical units and in days equivalents. A possible response to more frequent curtailments is to increase standby fuel storage capacity; therefore, the industries which plan such increases are identified.

The reactions of Kansas firms to the energy crisis include two major possibilities, conversion and conservation. The former is primarily a long run response whereas the latter is a commonly implemented short run reaction. The conversion plans of Kansas firms are discussed in this study, including the fuel types from which and to which the firms are changing and the estimated cost of conversion. Considerations which may cause firms to delay conversion decisions are also presented.

Analysis of the second response, conservation, requires estimation of the end uses of energy by industry and by fuel type, before the savings attributed to each technique can be quantified. The uses of energy at the point of consumption are divided into two types; commercial and industrial. Commercial end uses include consumption of energy for sales, service, and administration. The major commercial categories for which consumption is estimated in this study are space heating, water heating, cooking, refrigeration, air conditioning, and lighting. The primary industrial end uses are process steam, electric drive, electrolytic process, direct heat, and feedstock. The energy requirements for each of these end uses are estimated for the twenty-three industry groups and seven energy sources. In addition, examples of petrochemical requirements and their end uses are shown to illustrate the dependency of the state economy on petroleum derivatives.

Once the end uses of energy have been analyzed, conservation techniques can be presented in terms of the end uses on which they impact. Seven categories of conservation practices are considered: reduced lighting, improved insulation, reduced fuel requirements for space conditioning, more efficient vehicle usage, improved process efficiency, process curtailment, and compliance with the Voluntary Industrial Energy Conservation Program. Savings stemming from techniques within each category are estimated by fuel type, for the commercial firms, the industrial sector, and for the twenty-three industry groups as a whole.

Presentation of the gross[4] energy requirements of Kansas industries for each major energy source, along with the standby fuel system and end use analyses, provides a picture of the consumption patterns in existence at the onset of the energy crisis in 1973. This information then becomes the basis for analyzing the commercial and industrial firms' responses to that energy crisis, namely, changes in standby fuel systems, conversion of primary systems to accept alternate fuel types, and adoption of energy conservation programs.

CHAPTER II

ANNUAL GROSS ENERGY REQUIREMENTS OF COMMERCIAL AND INDUSTRIAL FIRMS IN KANSAS, 1973

Introduction

Estimation of the gross energy requirements of Kansas firms in 1973 was accomplished through the use of a sample survey and application of control numbers derived from government and private industry sources. The firms' energy consumption was disaggregated into seven major energy sources: natural gas, electricity, coal, gasoline, distillate and residual fuel oils, and liquid petroleum gas (LPG). The commercial sector was divided into six groups, and the industrial sector included sixteen manufacturing categories and mining. For each energy source, requirements were estimated by industry group and in total. These findings were compared with the results of other available studies, which were conducted at the national or multi-state level of detail. One difficulty associated with natural gas consumption, that of curtailments, has also been considered. The frequency of interruptions from 1970 through May 1974 was estimated for each industry represented in the sample. Use of interruptible natural gas generally involves maintenance of a standby fuel system; therefore, the types of standby systems and storage capacities were estimated for each industry.

Primary Data Source

The primary source of data for this study was a questionnaire sent to a sample of Kansas firms belonging to the Kansas Association of Commerce and Industry. A copy of this survey form appears in the Appendix. Part I of the questionnaire requested the energy requirements, in physical units, of the firm for each quarter in 1973 and for each of the first six months of 1974. Many respondents supplied only annual consumption data for 1973 or submitted incomplete data for 1974. Therefore, this report estimates usage for 1973 only, rather than drawing comparisons between the first half of 1973 and the first two quarters of 1974.

The next set of questions within Part I dealt with interruptible gas, standby systems, and conversion plans. Firms utilizing natural gas were asked if their supply was interruptible, and, if so, to what degree had their service been curtailed from 1970 through May 1974. Due to the widespread use of natural gas in Kansas, the frequency of curtailments could have a significant impact upon production and employment. Of greater importance than the number of hours curtailed was the possible increase in the duration and frequency of occurrence. Such changes in gas supply, particularly over a short period of time, could be disruptive, resulting in temporary unemployment and decreased output. However, the duration of curtailments should be compared with the storage

capacity of the standby fuel system in a given industry before the existence or extent of the problem can be determined. For this reason, the firms were asked to describe their standby systems in terms of the fuel type used, and volume and days equivalent of stored supply. In addition, the firms sampled were asked if they planned to increase the storage capacity. This answer would indicate how seriously the increased curtailments might be affecting the firms. Also, the firms were asked what, if any, plans they had to convert their primary fuel system from one fuel type to another. Again, conversion could indicate a problem with natural gas availability (and price expectations, especially for firm gas), or a response to the oil embargo, depending upon the nature of the conversion. The estimated cost of conversion was requested, to determine the capital requirements of such a decision. Parts II through IV will be discussed in later sections of this study; Part V of the survey form asked for the company employment, sales, and name.

The usable sample was comprised of 166 firms which represented approximately 15 percent of the state's 1973 employment in commercial and industrial firms. A "usable" response was one which gave consumption data in physical units and provided employment data for 1973. Some respondents presented energy consumption in dollar amounts, or failed to give company employment which eliminated the means to scale sample information to the state level.

Secondary Data Sources

The ratio of total state employment in a given industry to the sample employment in that industry provided the means to scale sample energy consumption to the state level. Several sources of state employment by industry in 1973 are available. The Bureau of Labor Statistics publishes nonagricultural employment by industry, including federal, state, and local government employment.[5] The Bureau of the Census also provides employment data by industry, in the County Business Patterns series.[6] Data for agricultural services are available, but government employees, railroad employees, and self-employed persons are excluded. For the manufacturing sector, the Annual Survey of Manufactures gives employment, payroll, production manhours, value added, cost of materials, value of shipments, and capital expenditures by industry.[7] Government employment, federal civilian, state, and local, is also available from the Statistical Abstract.[8] The Bureau of Labor Statistics and Annual Survey of Manufactures both publish the number of employees in thousands, with one decimal place, and each omits certain industries for which data were required. Therefore, the County Business Patterns was selected as the primary source of employment data. The other two references were used as supplements where necessary.

Other measures of production or economic activity, such as value added or retail sales were considered as possible

scale factors at the time the survey was designed. However, very few of the sample firms provided any form of sales data. While an energy per dollar of sales figure might have provided a better measure of consumption, such a ratio was unavailable.

The development of control numbers for industries within manufacturing involved both types of ratios as well as interpolation. Detailed statistics on energy consumption (other than electricity) were not published for 1973. Data concerning electricity consumption, 1972 through 1975, is available by industry for Kansas, as is the aggregate fuel and electric consumption.[9] Employment and value added statistics are also provided for 1972 through 1976 by the Annual Survey of Manufactures.[10] Estimates of fuel consumption within manufacturing obtained from the above-mentioned statistics served as approximate guidelines within that sector. Another valuable source of energy requirements by industry for Kansas was Provisional Energy Demand Estimates for Kansas Industries,[11] which estimated energy use for 1969 and provided projections for 1980, 1990, and 2000. Other sources of information for each fuel type will be discussed in turn.

Natural Gas Consumption

The American Gas Association (AGA) publishes gas utility sales by state and class of service annually. Their definition of industrial service includes manufacturing and mining

customers. Commercial service encompasses all other Standard Industrial Classification categories, including offices which are part of a residence, institutions, and multi-family dwellings having five or more units. Accepting the AGA definitions, gas sales to commercial firms equaled 36.9 billion British Thermal Units (BTU) and industrial sales were 354.9 billion BTU, in 1973.[12] The average BTU content of gas sold in Kansas was 988 BTU per cubic foot.[13] Converted to thousands of cubic feet (MMCF), and added to gas used to produce electricity,[14] the total commercial and industrial consumption for 1973 would be 572,733 MMCF. The AGA statistics exclude sales from pipelines to ultimate consumers, so the survey estimate of 575,428 MMCF is consistent with the above data.

The FEDS data base includes agriculture with industrial consumers, and treats transportation as a separate sector rather than part of residential, commercial, and industrial classes.[15] This source states that commercial natural gas consumption totalled 52.67 billion cubic feet (BCF)[16] in 1973, with industrial use at 206.71 BCF.[17] Transportation consumed 72.93 BCF.[18] Excluding natural gas for electricity generation, for which the FEDS number agrees with the AGA,[19] the total commercial, industrial, and transportation figure comes to 332.32 BCF. Including the electric utility sector, the total is 508.48 BCF. Considering the differences in sector definitions, this study relies more on the AGA statistics.

Table 2-1 illustrates natural gas usage by industry in Kansas during 1973. The 176,174 MMCF consumed for electricity generation is included within the transportation, communications, and sanitary services category.

The largest, non-utility consumers of natural gas are the mining, petroleum, rubber, and stone industries. These four industries used more than 50,000 MMCF each during 1973, and together accounted for more than half of the commercial-industrial total. Other large users are the food, furniture, chemicals and service firms, who consumed between 12,000 and 28,000 MMCF each during 1973. Excluding utility use of natural gas for electricity generation, the commercial sector used 34.6 BCF and the industrial firms consumed 364.7 BCF in that year.

Electricity Consumption

Published data for electricity consumption are in closer agreement than are statistics for other fuels. Preliminary 1973 data on commercial-industrial electricity consumption is given to be 10,800 gigawatt-hours (GWH) in the Statistical Abstract, 1975.[20] This total represents usage of 4,500 GWH by the commercial firms and 5,300 GWH by the industrial firms. This breakdown will not coincide with Standard Industrial Classification codes, however. The Survey of Manufactures estimates 1973 industrial electricity usage at 4,600 GWH, which excludes mining.[21] The FEDS data base lists commercial

Table 2-1

ENERGY REQUIREMENTS OF KANSAS COMMERCIAL AND INDUSTRIAL FIRMS, 1973

Industry	Natural Gas[a] (MMCF)	Electricity[b] (GWH)	Coal & coke[a] (Thou. S.T.)	Gasoline (Mil. Gals.)	Distillate Fuel Oil & Kerosene[a] (TBTU)	Residual Fuel Oil[a] (TBTU)	(TBTU)
Agriculture	1,221	136	.....	219	11,787.6	42.9	340.8
Mining	117,502	165	.....	2	0.9	.....	675.6
Construction	7,195	37	.....	72	1,959.3	.....	203.7
Food & kindred products	12,069	764	.....	6	534.2	359.9	613.3
Apparel & related products	224	12	.....	.....	.....	.....	4.0
Lumber & wood products except furniture	612	.....	.....	.....	0.1	.....	.....
Furniture & fixtures	28,074	17	.....	.....	.....	.....	13.3
Paper & paper products	688	75	.....	.....	70.0	131.1	36.1
Printing & publishing	916	136	.....	3	.....	7.2	0.8
Chemicals & allied products	16,970	1,072	28	16	91.3	407.4	417.9
Petroleum & coal products	57,098	564	.....	24	.....	6,705.0	2,432.1
Rubber & plastic products	54,445	299	.....	1	.....	821.6	.....
Stone, clay & glass products	61,433	848	194	9	5,352.9	552.3	382.1
Primary metals	2,496	179	2	.....	.....	.....	570.0
Fabricated metals	2,444	177	8	6	268.9	.....	307.3
Machinery, except electrical	3,742	164	8	2	19.1	.....	51.0
Electrical machinery	54	105	.....	.....	.....	.....	.....
Transportation equipment	5,525	472	1	23	81.8	426.0	309.8
Miscellaneous manufacturing	380	67	4	3	93.2	298.6	2.7
Transportation, communications, & sanitary services	177,124	273	1,620	529	37,498.0	7,455.8	4,011.9
Wholesale & retail trade	2,762	852	.....	28	442.4	.....	1,122.2
Finance, insurance, & real estate	716	413	.....	5	8.5	653.8	209.1
Services	21,738	3,480	.....	49	26.4	163.5	652.1
TOTAL	575,428	10,307	1,865	997	58,234.6	17,925.1	12,355.8

a) Includes fuel for electricity generation
b) Includes self-generation

electricity consumption at 5,570 GWH and industrial usage at 5,320 GWH, where industrial includes agriculture.[22] Statistics concerning industrial generation of electricity are available in the Annual Survey of Manufactures, and in the Statistical Abstract.[23] Other data on sales, losses, and electricity usage by utility companies can be found in Federal Power Commission reports. Privately owned utilities reported company use of 43,793 megawatt-hours (MWH), while publicly owned companies consumed 2,941 MWH in 1973.[24] In the year 1975, there were 136 municipally owned electric systems in Kansas, of which 31 generated their own electricity, 70 purchased their entire requirements, and 35 both generated and purchsed power.[25] The majority of the power purchased by the municipally owned systems was generated by investor-owned utilities.[26] The small amount of hydroelectric power in Kansas is distributed by the Southwest Power Administration; this amounted to 3 GWH in 1973.[27]

This study estimates total electricity usage of 10,307 GWH for 1973. The industries consuming the largest amounts of electricity are food, chemicals, stone, and wholesale and retail trade; these groups used more than 750 GWH each. Other major consumers are the petroleum and transportation equipment firms. The commercial industries accounted for 5,191 GWH and the industrial sector consumed 5,116 GWH during 1973.

Coal and Coke Consumption

The major user of coal is the electric utility industry, which consumed 1.62 million short tons (S.T.) of coal to generate electricity in 1973; the manufacturing firms, according to the FEDS data base, used 1.2 million short tons of coal.[28] Van Arsdall estimates industrial coal use during 1967 in Kansas to be approximately 2.04 million short tons.[29] Within manufacturing, Van Arsdall found the coal using industries to be chemicals, petroleum and coal products, rubber and plastics, stone, clay and glass, primary metals, and miscellaneous manufacturing. The Annual Survey of Manufactures indicates coal consumption in 1974 by chemicals, stone, clay, and glass, fabricated metals, and transportation equipment industries; however, quantities are not disclosed.[30] This study estimates coal consumption for chemicals, stone, clay and glass, primary metals, fabricated metals, machinery, transportation equipment, and miscellaneous manufacturing industries.

Gasoline Consumption

Very few of the sample firms supplied their gasoline consumption; therefore Emerson's Provisional Energy Demand Estimates for Kansas Industries is used to allocate usage among the industries. In that study, the estimates of 1969 gasoline consumption are based upon statistics from the American Petroleum Institute and the Bureau of Mines. For 1973, the

Bureau of Mines states that total gasoline usage in Kansas was 1433 million gallons; this total includes residential, commercial, and industrial use for transportation.[31] The FEDS estimates are considerably lower and imply a higher growth rate from 1969 to 1973, namely from 1248 million gallons to 1342 million gallons. Table 2-1 shows the allocation of 997 million gallons among the industries; 902 million are consumed by the commercial sector and 95 million by the industrial sector. The remainder of the 1433 million gallons, that is, 436 million, would be residential transportation.

Distillate Fuel Oil and Kerosene Consumption

According to the Bureau of Mines, distillate fuel oil and kerosene consumption totalled 60.9 trillion BTU (TBTU) in Kansas during 1973. Of this amount, 6.6 TBTU were used by the household-commercial sector, 16.5 TBTU by industrial firms, 33.5 TBTU by the transportation sector, 3.5 TBTU by electric utilities, and 0.8 TBTU by miscellaneous consumers.[32] The FEDS data base reports 57.91 TBTU of distillate oil consumed.[33] The survey results in an estimate of 58.2 TBTU, of which 6.5 TBTU are industrial, 48.2 TBTU are commercial, and 3.5 TBTU are for electricity generation. The main differences are due to sectoral definitions, and inclusion of the household sector in Bureau of Mines statistics.

The major users of distillate fuel oil are agriculture, construction, stone, and transportation services industries. This study estimates commercial sector usage to be 39,934.6

billion BTU and industrial consumption at 18,300 billion BTU, for a total of 58,234.6 billion BTU.

Residual Fuel Oil Consumption

The Bureau of Mines reports that 17.9 TBTU of residual fuel oil were consumed within Kansas in 1973. Households and commercial firms accounted for 0.8 TBTU, industrial firms 9.4 TBTU, the transportation sector 0.4 TBTU, consumers 0.4 TBTU.[34] The FEDS study shows a total 17.925 TBTU.[35] As with distillate oil, sectoral definition differences prevent direct comparison of usage by more detailed categories.

Dominant residual fuel oil users are the petroleum and transportation services industries, which consume about 78 percent of the total. The commercial firms use 8,316.0 billion BTU; the industrial firms consume 9,609.1 billion BTU.

LPG Consumption

Total LPG consumption in Kansas equalled 29.3 TBTU, according to the Bureau of Mines, in 1973.[36] Again, the total includes household usage, which the FEDS data base states was 20.21 TBTU.[37] The FEDS study lists commercial consumption as 2.25 TBTU, industrial as 6.16 TBTU, and transportation as 3.95 TBTU, for a total of 32.57 including households or 12.36 excluding them.[38] The survey results are generally consistent with both of these sources.

The methodology described above is similar to that of Myers, who relied upon surveys, literature on the industries,

the Census of Manufactures, Bureau of Mines, and Federal Power Commission reports for data in estimating energy use per industry for the nation.[39] On a total BTU basis, he found the major energy users in manufacturing were the food, paper, chemical, petroleum, stone, and primary metals industries.[40] Table 2-1 shows that is the case in Kansas, also, with the possible exception of the paper industry. Natural gas was the primary source of energy among the major energy users in Myer's study; the food and stone industries also listed electricity as a primary source. Fuel oils were more frequently cited as main fuels by the chemical firms; only in one industry, primary metals, was coal named more often than natural gas as a major fuel.[41]

In Kansas, over 60 percent of the energy requirements of commercial and industrial firms are met by natural gas. The major energy users within manufacturing are also heavily reliant upon natural gas, and consumed 38 percent of the commercial-industrial total (excluding natural gas for electricity generation). The food, chemical, petroleum, stone, and transportation equipment industries are the major consumers of electricity within manufacturing. The chief coal users are the chemical, stone, fabricated metals, and machinery industries. The largest fuel oil consumption is among food, petroleum products, and stone, clay, and glass firms.

Gray notes that in 1973, 26.2 percent of the primary

energy supply in the United States was converted to electricity.[42] In Kansas 22.3 percent was converted to and used in the form of electricity. Excluding the primary fuels used to generate electricity, 61.8 percent of the BTU consumption of commercial-industrial firms in Kansas was in the form of natural gas; 5.5 percent was electricity; 0.9 percent was coal or coke; 19.6 percent was gasoline; 10.3 percent was fuel oil; and 1.9 percent was LPG.

Excluding the primary fuels which are used to generate electricity, the Federal Energy Administration (DOE) estimates the following fuel mix within the commercial sector, based upon a study by Jack Faucett Associates:[43]

Fuel Type	Percentage
Electricity	33.5
Natural gas	41.6
Fuel oil	17.9
LPG	1.9
Coal	2.6
Steam	2.4

Estimates for Kansas commercial firms in 1973, which differ because the transportation sector's consumption is included are as follows:

Fuel Type	Percentage
Electricity	16.4
Natural gas	31.6
Fuel oil	45.9
LPG	6.1

In the industrial sector in Kansas, the mix is remarkably different:

Fuel Type	Percentage
Electricity	4.3
Natural gas	88.8
Coal	1.5
Fuel oil	4.0
LPG	1.4

In 1968, Stanford Research Institute estimated that the six major energy users among manufacturing firms consumed 16,910 TBTU. Of this amount, coal represented 27.4 percent, natural gas 26.5 percent, petroleum 22.2 percent, and electricity 23.9 percent.[44] These same industries (primary metals, chemicals, petroleum products, food, paper, and stone) consumed 184.4 TBTU during 1973, in Kansas. Coal represented 3.0 percent of the total, natural gas 80.7 percent, petroleum 9.8 percent, and electricity 6.5 percent. Ignoring changes over time, such variations in energy inputs reflect differing industrial mixes in Kansas versus the nation as a whole, and variations in production techniques due to different prices and degrees of availability of inputs.

The Extent of Natural Gas Curtailments

In the commercial sector, 5.7 percent of the natural gas sold by utilities was interruptible; in the industrial class of service, 74.8 percent was interruptible gas.[45] Sample firms having interruptible service agreements were asked to

indicate the number of hours they were curtailed each year, from 1970 through May 1974. The estimated hours of curtailment in the state are shown, by industry, in Table 2-2. The data for 1970 and 1971 are subject to error in that many firms had no accurate information for those years.

The majority of curtailments occurred within manufacturing, and, in general, increased between 1972 and 1973. Total hours for all industries increased by 32.9 percent between 1972 and 1973, and according to the trend of the first five months of 1974, would have risen again by 38.5 percent. Among the commercial firms, hours curtailed increased by 11.8 percent from 1972 to 1973, and apparently by 127.9 percent from 1973 to 1974. Within the manufacturing sector, the hours increased by 38.7 percent in the former period and by 18.5 percent in the latter.

Table 2-2

In Myer's study, firms were asked to cite non-price difficulties which they were currently facing. The food industry indicated that 32.1 percent of their natural gas use was interruptible, and that 24.7 percent of their normal light fuel oil use was affected by market unavailability. The chemical firms said that 21.9 percent of their gas usage was subject to curtailment and 31.9 percent of their light fuel oil use was threatened by shortages. In the petroleum and coal products industry, 40.2 percent of the gas service was interruptible but little problem with oil shortages was mentioned. The stone, clay, and glass firms reported 45.8 percent interruptible gas, and 43 percent of their light fuel oil use was

Table 2-2

TOTAL HOURS OF NATURAL GAS CURTAILMENT FOR ALL INDUSTRIES

Industry	1970	1971	1972	1973	1974 (Jan.-May)
Agricultural services	0	0	0	13,248	0
Oil & gas extraction	0	0	0	0	0
Construction	0	0	0	0	0
Food & kindred products	240,248	186,592	225,680	287,040	91,000
Apparel & related products	0	0	0	0	0
Lumbar & wood products, except furniture	357	714	3,536	7,072	10,608
Furniture & fixtures	1,903	1,903	1,903	1,903	0
Paper & paper products	1,122	9,828	21,825	25,812	11,691
Printing & publishing	0	0	0	348	387
Chemicals & allied products	16,968	21,024	30,390	35,568	27,252
Petroleum & coal products	2,400	4,980	5,850	6,654	3,264
Rubber & rubber products	960	998	1,805	2,419	1,267
Stone, clay & glass	20,790	29,050	51,275	111,825	75,950
Primary metal products	1,956	3,484	5,828	5,348	2,170
Fabricated metal products	1,197	1,269	5,625	9,876	5,856
Machinery, except electrical	591	8,460	25,782	32,472	26,199
Electrical machinery	0	0	0	0	0
Transportation equipment	1,460	1,732	8,892	11,976	8,400
Miscellaneous Manufacturing	0	0	0	215	2,040
Transportation, communications, and utilities	77,418	80,448	91,446	71,586	67,320
Wholesale trade	0	0	2,491	3,737	6,695
Retail trade[a]	0	0	0	0	0
Finance, insurance & real estate	0	0	0	0	0
Services	3,700	5,046	13,456	27,920	39,696

[a]No firms of this type in the sample had interruptible natural gas.

affected by market unavailability. Among primary metal products firms, the amount of natural gas usage subject to curtailment was 31.5 percent.[46]

Standby Fuel Systems

Largely because of interruptible service many firms have standby systems and more are being added. Use of standby fuel systems in Kansas is associated with presence of interruptible natural gas service agreements. In the sample, 36 percent of the firms had interruptible gas and maintained a standby facility, while 48 percent had firm gas and no standby fuel system.

Fuels used in standby facilities include grade numbers two, five, six, and diesel fuel oil, crude oil, LPG, and coal. For each industry the types of standby fuel used, the storage capacity and its days' equivalent are given in Table 2-3. Many firms used two or more fuels on a standby basis since various phases of their production process required different energy sources. The total standby capacity varied greatly among industries, as did the days' equivalent of the capacity. For example, both primary metal industries and wholesale trade stored only a four day supply of fuel, whereas rubber and plastic products had a sixty-five day capacity and transportation equipment more than a one hundred day supply of fuel oil. Estimates of standby fuel capacities and their days equivalents were obtained from the survey. Seven industries in the sample did not report use of standby fuels and therefore

Table 2-3
STANDBY FUEL SYSTEMS OF KANSAS INDUSTRIES

Table 2-3

STANDBY FUEL SYSTEMS OF KANSAS INDUSTRIES

Industry	Fuel Type	Capacity	Days' Equivalent
Construction	Propane	951,600 Gals.	a
	No. 2 fuel oil	951,600 Gals.	a
Food and kindred products	No. 2 fuel oil	283,569 Gals.	26
	No. 5 fuel oil	1,136,298 Gals.	94
	No. 6 fuel oil	1,785,674 Gals.	39
	Diesel fuel oil	780,000 Gals.	30
	Crude oil	45,825 Gals.	a
	LPG	149,500 Gals.	8
Apparel and related products	No. 1 fuel oil	58,200 Gals.	14
Lumber and wood products except furniture	No. 2 fuel oil	340,000 Gals.	15
Furniture and fixtures	No. 2 fuel oil	208,000 Gals.	a
Paper and paper products	No. 2 fuel oil	155,630 Gals.	17
	No. 5 fuel oil	94,600 Gals.	a
	No. 6 fuel oil	184,900 Gals.	18
Printing and publishing	No. 5 fuel oil	55,900 Gals.	6
Chemicals and allied products	No. 2 fuel oil	76,860 Gals.	18
	No. 6 fuel oil	204,398 Gals.	20
	LPG	132,600 Gals.	7
	Coal	170,000 S.T.	a

Table 2-3 Continued

STANDBY FUEL SYSTEMS OF KANSAS INDUSTRIES

Industry	Fuel Type	Capacity	Days' Equivalent
Petroleum and coal products	Propane	60,000 Gals.	a
Rubber and plastic products	No. 6 fuel oil	15,600,000 Gals.	65
Stone, clay and glass products	No. 2 fuel oil	1,337,000 Gals.	40
	No. 6 fuel oil	15,540,000 Gals.	161
	LPG	266,000 Gals.	12
	Coal	151,368 S.T.	68
Primary metal products	LPG	237,150 Gals.	4
Fabricated metal products	No. 2 fuel oil	252,000 Gals.	10
	Nos. 5 & 6 fuel oil	271,600 Gals.	a
	LPG	220,259 Gals.	a
Machinery, except electrical	No. 2 fuel oil	155,800 Gals.	5
	Nos. 5 & 6 fuel oil	1,025,000 Gals.	28
	LPG	984,000 Gals.	12
Transportation equipment	No. 2 fuel oil	81,926 Gals.	101
	No. 6 fuel oil	1,052,600 Gals.	10
	LPG	222,980 Gals.	8
	Coal	1,520 S.T.	365
Transportation, communications, and utilities	No. 2 fuel oil	571,271 Gals.	25

Table 2-3 Continued

STANDBY FUEL SYSTEMS OF KANSAS INDUSTRIES

Table 2-3 Continued

STANDBY FUEL SYSTEMS OF KANSAS INDUSTRIES

Industry	Fuel Type	Capacity	Days' Equivalent
Wholesale trade	LPG	830,400 Gals.	4
Finance, insurance and real estate	No. 2 fuel oil	138,925 Gals.	9
Services	No. 2 fuel oil	630,750 Gals.	10
	No. 5 fuel oil	7,500,000 Gals.	14
	Propane	2,186,600 Gals.	10

[a]Figures are not available.

no estimates appear for those industry groups in Table 2-3.

Planned Increases in Standby Fuel Storage Capacity

Only firms in four industries reported plans to increase their storage capacities for standby fuel: food and kindred products, printing and publishing, chemicals and allied products, and stone, clay and glass products. Most of these firms intended to at least double the capacity of their standby facilities, as illustrated in Table 2-4.

It should be noted that the food, stone, and chemicals firms are among the top seven energy users in Kansas industries and they experienced the greatest curtailments of natural gas service during 1973. As shown in Table 2-2, the food industry was curtailed 387,040 hours, or approximately 32 days. Thus, a decision to increase storage capacity from 4.5 days' equivalent to 22.5 could be a response to these interruptions. The hours of curtailment more than doubled in the stone, clay, and glass group between 1972 and 1973, and the firm increasing its storage capacity raised it by 91 percent. In addition, the food and stone firms showing planned increases had storage facilities smaller than their industry averages. The chemicals industry showed an increase in natural gas interruptions of nearly 17 percent, and the printing firms experienced their first curtailments in 1973. When curtailments in natural gas service increase, some firms, especially those having less than average standby fuel storage capacities, can be expected to increase their storage facilities.

Table 2-4

PLANNED INCREASES IN STANDBY FUEL CAPACITIES OF KANSAS INDUSTRIES

Industry	Fuel Type	Increase (Gallons)	Percent Increase	Days' Equivalent of Increase
Food and kindred products	No. 6 fuel oil	6,500,000	400.0	18
Printing and publishing	No. 5 fuel oil	86,000	154.0	9
Chemicals and allied products	Nos. 5 & 6 fuel oil	646,000	100.0	30
Stone, clay and glass products	Nos. 5 & 6 fuel oil	1,400,000	91.0	14

CHAPTER III

END USES OF ENERGY IN KANSAS INDUSTRIES

Commercial End Uses by Industry and by Fuel Type

Commercial end uses are defined to include consumption of energy for sales, service, and administration. Typical categories under commercial uses are space heating, water heating, cooking, refrigeration, air conditioning, and lighting. Estimation of the fuel requirements for these end uses is necessary before savings stemming from various conservation practices can be calculated.

Part III, Section A of the questionnaire dealt with commercial end uses of energy. For each fuel type, the firm was asked to give the percent allocation among a list of use categories. For each energy source, the average percentage per use category could then be calculated. For example, under Agricultural Services, an average of 89 percent of commercially used natural gas was accounted for by space heating, 4 percent by water heating, and 7 percent by miscellaneous end uses. Fuel requirements, in physical units, for commercial end uses are shown in Tables 3-1 through 3-6.

For all industries except food and kindred products and fabricated metal products, natural gas space heating accounted for at least 75 percent of the commercial use of natural gas.

Table 3-1

COMMERCIAL END USES OF NATURAL GAS (MMCF), 1973

Industry	End Uses					
	Space Heating	Water Heating	Cooking	Air Conditioning	Other	Electricity Generation
Agriculture	1,082	48	.....	.....	91	.....
Mining	2,230	3	.....	.....	.....	.....
Construction	4,981	766	.....	639	.....	.....
Food and kindred products	2,414	222	576	77	549	.....
Apparel and related products	92	8	.....	.....	.....	.....
Lumber and wood products, except furniture	8,100	41	.....	.....	.....	.....
Paper and paper products	230	11	.....	.....	.....	.....
Printing and publishing	706	30	2	105	.....	.....
Chemicals and allied products	4,083	78	.....	421	.....	.....
Petroleum and coal products	1,704	.....	.....	9	.....	.....
Rubber and plastic products	7,392	67	.....	.....	.....	.....
Stone, clay and glass products	6,197	192	.....	.....	.....	.....
Primary metals	593	118	.....	.....	.....	.....
Fabricated metals	1,106	287	7	.....	.....	.....
Machinery, except electrical	2,987	53	.....	.....	.....	.....
Electrical machinery	49	5	.....	.....	.....	.....
Transportation equipment	582	101	.....	91	.....	.....
Miscellaneous manufacturing	330	3	.....	.....	.....	.....
Transportation, communications and sanitary services	913	37	.....	.....	.....	176,174
Wholesale and retail trade	2,527	215	20	.....	.....	.....
Finance, insurance, and real estate	651	20	1	44	.....	.....
Services	14,139	2,113	18	1,338	.....	.....
Total	63,100	4,418	624	2,715	640	176,174

Table 3-2

COMMERCIAL END USES OF ELECTRICITY (GWH), 1973

	Space Heating	Water Heating	Cooking	Refrigeration	Air Conditioning	Lighting	Office Machines	Other
Agriculture	60	.....	.....	.....	65	.....	.....	11
Mining	2	.....	.....	.....	16	16	.....	.....
Construction	4	.....	.....	.....	13	14	2	.....
Food and kindred products	13	1	9	69	55	29	67	.....
Apparel and related products	.....	.....	.....	.....	1	2	.....	a
Lumber and wood products	.....	.....	.....	.....	.....	.....	.....	.....
Furniture and fixtures	.....	.....	.....	.....	2	a	2	.....
Paper and paper products	a	.....	.....	.....	12	6	.....	.....
Printing and publishing	11	1	1	1	31	11	.....	.....
Chemicals and allied products	18	2	1	41	154	74	.....	21
Petroleum and coal products	a	2	.....	.....	12	3	.....	.....
Rubber and plastic products	8	1	.....	1	31	20	.....	.....
Stone, clay, and glass products	22	.....	.....	.....	5	20	.....	7
Primary metals	.....	1	.....	.....	6	6	.....	.....
Fabricated metals	2	.....	4	2	15	7	.....	.....
Machinery, except electrical	3	a	.....	.....	31	80	.....	.....
Electrical machinery	.....	.....	.....	.....	26	26	.....	.....
Transportation equipment	2	.....	8	26	22	62	.....	.....
Miscellaneous manufacturing	2	1	a	1	15	19	.....	.....
Transportation, communications, and sanitary services	20	1	a	a	83	124	9	36
Wholesale and retail trade	22	5	1	184	163	274	122	81
Finance, insurance and real estate	26	2	1	4	138	230	12	.....
Services	181	17	6	84	1,180	1,308	8	.....
Total	396	34	31	413	2,076	2,331	222	156

a less than 500 MWh

Table 3-3

COMMERCIAL END USES OF COAL (THOU. S.T.), 1973

	End Uses	
	Space Heating	Electricity Generation
Stone, clay, and glass products	20.0	.....
Transportation equipment	0.4	.....
Miscellaneous manufacturing	4.0	.....
Transportation, communications and sanitary services	.....	1,620
Total	24.4	1,620

Table 3-4

COMMERCIAL END USES OF DISTILLATE FUEL OIL AND KEROSENE (TBTU), 1973

Industry	End Uses			
	Space Heating	Water Heating	Trans-portation	Electricity Generation
Mining	0.8	.....	.....	.....
Food and kindred products	59.0	11.0	.....	.....
Stone, clay, and glass products	.....	.....	894.0	.....
Fabricated metals	161.4	40.3	.....	.....
Machinery, except electrical	19.1	.....	.....	.....
Miscellaneous manufacturing	65.8	.....	.....	.....
Transportation, communications, and sanitary services	1,246.0	52.0	32,365.0	3,835.0
Total	1,552.1	103.3	33,259.0	3,835.0

Table 3-5

COMMERCIAL END USES OF RESIDUAL FUEL OIL (TBTU), 1973

Industry	End Uses				
	Space Heating	Water Heating	Cooking	Transportation	Electricity Generation
Food and kindred products	96.0	24.0	.....	.....	.....
Miscellaneous manufacturing	138.2	.....	.....	.....	.....
Transportation, communications, and sanitary services	.....	.....	.....	440.0	6,915.0
Services	155.0	6.5	2.0	.....	.....
Total	389.2	30.5	2.0	440.0	6,915.0

Table 3-6

COMMERCIAL END USES OF LPG (TBTU), 1973

Industry	End Uses				
	Space Heating	Water Heating	Refrigeration	Materials Handling	Transportation
Mining	6.8	.....	.....	.....	.....
Food and kindred products	.....	.....	10.0	399.0	.....
Apparel and related products	.....	.....	.....	2.0	.....
Primary metals	185.3	.....	.....	.....	.....
Fabricated metals	99.9	.....	.....	.....	.....
Machinery, except electrical	10.7	.....	.....	10.6	.....
Transportation equipment	32.7	7.6	.....	.....	.....
Miscellaneous manufacturing	2.7	.....	.....	.....	.....
Transportation, communications and sanitary services	.....	.....	.....	.....	4,012.0
Services	619.5	.....	.....	.....	.....
Total	957.6	7.6	10.0	411.6	4,012.0

The food industry used a smaller percentage for space heating and a much larger amount than other firms for cooking and cleaning. Fabricated metals firms required a smaller proportion of their natural gas for heating than other firms but more for water heating. The amount of natural gas used for water heating is generally from 2 percent to 8 percent, with higher percentages for construction, food, metal, and transportation equipment industries. Natural gas air conditioning was used by some firms in construction, food, printing, chemicals, transportation equipment and finance industries, accounting for 10, 2, 12.5, 49.5, and 6.1 percent of the firms' commercial natural gas usage, respectively. Table 3-1 illustrates the commercial end uses of natural gas in Kansas for each industry.

Overall, 88.2 percent of the commercial use of natural gas is accounted for by space heating, 6.2 percent by water heating, 0.9 percent by cooking, 3.8 percent by air conditioning, and 0.9 percent by other end uses. The percentages exclude the 176,174 MMCF used to generate electricity. This distribution of end uses can be compared with the Federal Energy Administration's 1974 findings for the West North Central region, which were: 80.2 percent space conditioning, 8.1 percent water heating, 4.0 percent cooking, 7.7 percent other.[47] Stanford Research Institute found a much larger percentage of natural gas being used for water heating, 22.9. Their other findings were 65.5 percent space heating, 6.3 percent cooking, and 5.3 percent air conditioning.[48]

The pattern of commercial electric end uses is more variable than that of the primary fuels, such as natural gas. Electric space heating usage requires from 1.2 percent to 44.4 percent of a firm's commercial total. The paper, petroleum, and transportation equipment industries used the least portion for space heating, while the stone, clay and glass and agricultural services firms recorded the largest shares.

Water heating took approximately 1 percent of commercially used electricity per firm having electric hot water. Machinery and transportation, communications, and sanitary services reported the smallest percentages for water heating, and the petroleum products and primary metals firms, the largest.

Refrigeration necessitated from 0.1 to 28.6 percent of a firm's commercial consumption, with the greatest proportions cited by food, chemicals, transportation equipment, and trade industries. Generally less than 1 percent of a firm's electricity was used for cooking, although the food, fabricated metals, and transportation equipment firms reported much higher portions.

The amount used for air conditioning varied from 10.0 to 71.7 percent, with the stone, clay and glass firms using the smallest percentages of commercial electricity for this purpose, and petroleum products, the largest. Lighting required from 11.9 to 70.5 percent, for food and apparel, respectively. Table 3-2 gives the commercial end uses of electricity by industry.

For the entire commercial-industrial sector, the proportions of electricity going to each commercial end use are as follows:

End Use	Percentage
Space heating	7.0
Water heating	0.6
Cooking	0.5
Refrigeration	7.3
Air conditioning	36.7
Lighting	41.2
Office machines	3.9
Other	2.8

The Federal Energy Administration estimated, for the West North Central region, that 35.1 percent of commercial electricity was used for space conditioning, 3.0 percent for cooking, 45.0 percent for lighting, 7.5 percent for refrigeration, and 9.4 percent for other end uses.[49] Stanford Research Institute listed the following percentage shares: water heating 7.8; cooking 0.7; refrigeration 22.6; air conditioning 34.3; other 34.6.[50]

Coal is used entirely for space heating, aside from the 1,620,000 short tons for electricity generation. The Federal Energy Administration shows 93.3 percent in the space heating category and 6.7 percent in the water heating area; Stanford Research Institute estimates that 100 percent of commercial coal is used for space heating.[51]

Commercial use of distillate fuel oil and kerosene is limited to space heating (4.4 percent), water heating (0.3 percent), and transportation (95.3 percent). Electricity

generation was excluded from these calculations; 3,835 billion BTU were used for this purpose. Similarly, residual fuel oil was used for space heating (45.2 percent), water heating (3.5 percent), and cooking (0.2 percent), with 51.1 percent used for transportation. Electricity generation consumed 6,915 billion BTU. Combining these two fuel oil types and excluding transportation and electricity generation, 93.4 percent was used for space heating, 6.4 percent for water heating, 0.1 percent for water heating, and 0.1 percent for cooking. The Federal Energy Administration showed values of 79 percent, 12 percent, and 9 percent in the categories of space heating, water heating, and other, respectively.[52] Tables 3-4 and 3-5 illustrate the commercial end uses of distillate and residual fuel oils.

LPG was used commercially for space heating (17.7 percent), water heating (0.2 percent), refrigeration (0.2 percent), and materials handling and transportation (81.9 percent). Omitting the last category, the percentages would be 98.2, 0.8, and 1.0. In the West North Central area, the portions were very different. Space heating accounted for 49.2 percent, water heating was 15.7 percent, and cooking used 35.1 percent.[53] Table 3-6 shows the end uses of LPG.

After converting physical units to BTU, the commercial end use shares were calculated for all fuels combined:

End Use	Percentage
Space heating	71.8
Water heating	4.9
Cooking	0.8
Air refrigeration	10.4
Refrigeration	1.5
Lighting	8.5
Other	2.1
Total	100.0

Other estimates show that space conditioning accounts for 61 to 79 percent of commercial energy consumption, water heating from 3 to 9 percent, refrigeration 2 to 4 percent, lighting 6 to 15 percent, and miscellaneous end uses up to 22 percent.[54]

Industrial End Uses by Industry and by Fuel Type

Industrial end uses are those involved in manufacturing or processing. The principal categories of industrial use are process steam, electric drive, electrolytic process, direct heat, and feedstock.[55] Part III, Section B of the survey form requested that the firms supply data on their industrial uses of energy. For each fuel type, the firms were asked to estimate the proportions of that fuel used for each purpose. Tables 3-7 through 3-12 show the fuel requirements (in physical units or in BTU) for each end use by industry. Average percent shares for each use category were also calculated, for the seven energy sources, so that comparisons could be made with other studies.

Much of natural gas is used directly, that is, burned by industry for heat value.[56] Therefore, process steam and direct

Table 3-7
INDUSTRIAL END USES OF NATURAL GAS (MMCF), 1973

Table 3-7

INDUSTRIAL END USES OF NATURAL GAS (MMCF), 1973

Industry	End Uses				
	Process Steam	Direct Heat	Feedstock	Other	Electricity Generation
Mining	.....	.....	.....	115,269	.....
Construction	.....	.....	.....	809	.....
Food and kindred products	6,996	988	.....	.....	247
Apparel and related products	134	45	.....	.....	.....
Lumber and wood products	600	.....	.....	.....	.....
Furniture and fixtures	.....	19,933	.....	.....	.....
Paper and paper products	274	162	.....	.....	11
Printing and publishing	.....	73	.....	.....	.....
Chemicals and allied products	74	24	1	.....	2
Petroleum and coal products	25,089	30,296	.....	.....	.....
Rubber and plastic products	43,642	3,344	.....	.....	.....
Stone, clay, and glass products	10,679	44,365	.....	.....	.....
Primary metals	.....	1,740	.....	45	.....
Fabricated metals	26	1,018	.....	.....	.....
Machinery, except electrical	.....	640	.....	62	.....
Transportation equipment	1,435	3,316	.....	.....	.....
Miscellaneous manufacturing	.....	48	.....	.....	.....
Services	4,130	.....	.....	.....	.....
Total	93,079	105,992	1	116,185	260

Table 3-8

INDUSTRIAL END USES OF ELECTRICITY (GWH), 1973

Industry	End Uses					
	Process Steam	Direct Heat	Electric Drive	Electro-lytic Process	Materials Hand-ling	Other
Mining	.....	.....	.....	.....	.....	131
Construction	.....	.....	.....	.....	.....	4
Food and kindred products	.....	38	483	.....	.....	.....
Apparel and related products	.....	.....	9	.....	.....	.....
Lumber and wood products	.....	.....	a	.....	.....	.....
Furniture and fixtures	.....	.....	13	.....	.....	.....
Paper and paper products	.....	.....	57	.....	.....	.....
Printing and publishing	.....	16	64	.....	.....	.....
Chemicals and allied products	a	2	86	8	4	.....
Petroleum and coal products	.....	.....	547	.....	.....	.....
Rubber and plastic products	11	33	194	.....	.....	.....
Stone, clay, and glass products	.....	68	726	.....	.....	.....
Primary metals	.....	83	83	.....	.....	.....
Fabricated metals	.....	21	127	.....	.....	.....
Machinery, except electrical	.....	15	35	.....	.....	.....
Electrical machinery	.....	.....	53	.....	.....	.....
Transportation equipment	.....	65	284	3	.....	.....
Miscellaneous manufacturing	.....	1	28	.....	.....	.....
Services	.....	.....	696	.....	.....	.....
Total	11	342	3,485	11	4	135

a) less than 500 MWH

Table 3-9

INDUSTRIAL END USES OF COAL (THOU. S.T.), 1973

Industry	End Uses	
	Direct Heat	Feedstock
Chemicals and allied products	.....	28
Stone, clay, and glass products	174	.....
Primary metals	2	.....
Fabricated metals	8	.....
Transportation equipment	1	.....
Total	185	28

Table 3-10

INDUSTRIAL END USES OF DISTILLATE FUEL OIL AND KEROSENE (TBTU), 1973

Industry	End Uses				
	Process Steam	Direct Heat	Materials Handling, Vehicles	Other	Electricity Generation
Mining	.....	.....	.....	.....	.....
Construction	.....	.....	0.1	.....	.....
Food and kindred products	429.8	1,306.9	.....	752.4	.....
Lumber and wood products	0.1	33.4	.....	.....	.....
Furniture and fixtures	.....	.....	.....	.....	.....
Paper and paper products	70.0	a	.....	.....	.....
Chemicals and allied products	52.4	.....	.....	.....	.....
Stone, clay, and glass products	.....	7.5	.....	.....	15.0
Fabricated metals	1.7	1,471.4	1,516.1	.....	1,471.4
Transportation equipment	81.8[b]	65.5	.....	.....	.....
Miscellaneous manufacturing	24.9	.....	.....	.....	2.5
Services	26.4	.....	.....	.....	.....
Total	629.8	2,942.0	1,516.2	752.4	1,488.9

a) Less than 0.5 TBTU
b) Not separable

Table 3-11

INDUSTRIAL END USES OF RESIDUAL FUEL OIL (TBTU), 1973

Industry	End Uses		
	Process Steam	Direct Heat	Electricity Generation
Food and kindred products	233.9	6.0	.....
Paper and paper products	45.9	45.9	.....
Chemicals and allied products	367.1	27.3	13.0
Petroleum and coal products	1,408.0	5,297.0	.....
Rubber and plastic products	575.1	.....	.....
Stone, clay, and glass products	11.1	541.2	.....
Transportation equipment	426.0[a]		.....
Miscellaneous manufacturing	160.4	.....	.....
Total	2,929.3	6,215.6	13.0

a) Not separable

Table 3-12

INDUSTRIAL END USES OF LPG (TBTU), 1973

Industry	End Uses				
	Process Steam	Direct Heat	Feed-stock	Materials Handling and/or Vehicles	Other
Mining	.....	.....	....	96.8	572.0
Construction	.....	203.7	....	.....	.....
Food and kindred products	.....	153.2	....	51.1	.....
Apparel and related products	.....	.....	....	2.0	.....
Furniture and fixtures	.....	13.3	....	.....	.....
Paper and paper products	.....	.....	....	18.1	.....
Chemicals and allied products	.....	.....	188.1	229.8	.....
Petroleum and coal products	426.8	877.3	....	.....	1,067.0
Primary metals	.....	384.7	....	.....	.....
Fabricated metals	6.8	131.5	....	69.1	.....
Machinery, except electrical	7.4	.....	....	22.3	.....
Transportation equipment	54.7	130.4	....	84.4	.....
Services	.....	32.6	....	.....	.....
Total	495.7	1,926.7	188.1	573.6	1,639.0

heat should be the primary industrial end uses of natural gas. It is valued for these purposes because it has a high heat value and does not involve the problems common to many other primary fuels, such as air pollutants, solid waste, radiation emissions, and environmental destruction during production.[57] Table 3-7 illustrates the major industrial uses of natural gas. The largest consumers are the furniture, petroleum and coal, rubber and plastics, and stone, clay and glass companies. For all industries, 29.5 percent of industrial consumption of natural gas was for process steam, 33.6 percent for direct heat, less than 0.1 percent for feedstock, 0.1 percent for industrial electricity generation, and 36.8 percent for other purposes. These percentages will differ from those of the nation or census region because 36.5 percent of the total is consumed by one industry, mining, for pumping and dredging. Natural gas for feedstock was important in only one industry, chemicals.

The primary use of electricity in manufacturing was electric drive. The percentage distributions among industrial end uses were:

End Use	Percentage
Process steam	0.3
Direct heat	8.6
Electric drive	87.3
Electrolytic process	0.3
Other	3.5

Stanford Research Institute estimated 0.0 percent process steam, 5.4 percent direct heat, 79.6 percent electric drive,

11.7 percent electrolytic process, and 3.3 percent other uses.[58] Table 3-8 shows the industrial end uses of electricity by industry in Kansas.

Coal and coke were used mainly for direct heat; the remaining 13 percent usage was as a feedstock in the chemicals industry. National estimates showed that in 1968, 41.8 percent of coal was used for process steam, 1.7 percent for electricity generation, 53.9 percent for direct heat, and 2.6 percent for feedstock.[59] Table 3-9 lists the industries using coal and the amounts used for each purpose, excluding electricity generation.

The largest consumers of distillate fuel oil and kerosene were construction, food, and stone, clay and glass industries. The construction firms used oil for direct heat, paving, and forms. Food companies used distillate mainly for process steam. The stone, clay, and glass industry fuel oil usage was spread fairly evenly among three end uses: direct heat, vehicles, and electricity generation. In total, 8.6 percent of distillate oil was used for process steam, 40.1 percent for direct heat, 20.7 percent for vehicles, 20.3 percent for electricity generation, and 10.3 percent for other purposes. Table 3-10 gives the amounts per end use for each industry, excluding electricity generation by utilities.

The largest consumer of residual fuel oil was the petroleum and coal products industry. Excluding electricity generation by utilities, this industry used 60.9 percent of the residual oil required by the commercial-industrial sector. Of the

industrial consumption, process steam accounted for 32.0 percent, direct heat 67.9 percent and electricity generation 0.1 percent. The industrial end uses are illustrated in Table 3-11.

The industrial end uses of LPG, and percentage shares, are given below:

End Use	Percentage
Process steam	10.3
Direct heat	39.9
Feedstock	3.9
Materials handling or vehicles	11.9
Pumping and dredging	34.0

The primary consumers were the mining and petroleum and coal products industries, as shown in Table 3-12.

After converting the physical units to BTU equivalents, the industrial end uses of all fuels can be examined. Process steam accounts for 27.3 percent, direct heat 34.5 percent, feedstock 0.2 percent, electric drive 3.4 percent, materials handling and vehicles 0.6 percent, electricity generation by non-utility firms 0.6 percent, and other uses 33.4 percent.

Abelson reported the following (national) end use shares for 1974:[60]

End Use	Percentage
Process steam	40.5
Direct heat	27.9
Electric drive	19.2
Feedstock	8.7
Electrolytic process	2.9
Other	0.7

Other statistics for the nation, dated 1968, indicated that 40.6 percent of total net energy was used for process steam, 19.2 percent for electric drive, 2.8 percent for electrolytic processes, 27.8 percent for direct heat, 8.8 percent for feedstock, and 0.8 percent for other purposes.[61]

Total net commercial and industrial energy consumption was calculated by eliminating all direct fuel use for electricity generation, whether by utilities or by manufacturing firms. For Kansas in 1973, this total was 443,677 billion BTU. Of the total amount, the commercial sector consumed 21.1 percent and the industrial sector, 78.9 percent. These relative shares differ slightly from those estimated at the national level. Stanford Research Institute found that commercial firms used 25.8 percent of total commercial-industrial net energy; Darmstadter estimated that the commercial sector used 24.3 percent.[62]

Use of Petrochemicals by Kansas Industries

The sample firms were asked to list the petrochemicals used in production, the product or end use of the petrochemicals, and their average monthly requirements in Part II of the questionnaire. The majority of petrochemical users, 53 percent, were in printing and publishing, chemicals and allied products, petroleum and coal products, and rubber and plastic products. Table 3-13 illustrates the types of petrochemicals used by Kansas firms, and the uses to which they are applied. Table 3-14 gives the average monthly requirements of each petrochemical for Kansas

Table 3-13

USE OF PETROCHEMICALS BY KANSAS INDUSTRIES

	Petrochemical Type	Products or Use
1.	A-10 Activator	film developer
2.	Adhesive	printing
3.	Alcohol	anhydrous isopropyl printing pneumatic tires
4.	Antifreeze	conveyors machinery in general
5.	Cutting oils	conveyors
6.	Fuel oil	asphalt machinery in general solvents
7.	Extenders	pneumatic tires
8.	Gasoline	MIL-H-5606 machinery in general vehicles
9.	Gel coat	canoes
10.	Greases	machinery in general
11.	Hexane	pneumatic tires
12.	Hydraulic oils	film developer MIL-H-5606 machinery in general
13.	Icobutane	aerosol propellant

Table 3-13 Continued

Petrochemical Type	Products or Use
14. Ink	pressure sensitive decals newspapers
15. Jet fuel	MIL-H-5606
16. Liquid fix	film developer
17. Liquidlith	film developer
18. Lubricant oils	lubrication machinery in general
19. Lubricant oils, greases	conveyors
20. Methanol	methyl chloride pneumatic tires
21. Methyl ethyl ketone	plastics, plastic products industrial gases telephone set repair
22. Methyl isoampyle ketone	pneumatic tires
23. Methylene chloride	plastics, plastic products industrial gases
24. Mineral seal oil	
25. Mineral spirits	cleaning products plastics, plastic products industrial gases
26. Motor oils	machinery in general
27. Natural gas	ammonia chloroform methylene chloride
28. P.M.T.	film developer

Table 3-13 Continued

Petrochemical Type	Products or Use
29. Paints	camping products conveyors heating, air conditioning equipment MIL-H-5606
30. Parafin	wax
31. Petrodistillate	press roller cleaner solvents
32. Petroleum	asphalt no. 2 fuel oil
33. Phenol	pentachlorophenol
34. Plastics	camping products heating, air conditioning equipment plastics, plastic products pressure sensitive decals pet food industrial gases
35. Polybutyldiene	rubber
36. Polyester enamel	canoes
37. Polyethylene	milk cartons, ice cream containers plastics, plastic products pet food industrial gases
38. Polypropylene	pet food
39. Polystyrene	expandable
40. Propane	aerosol propellant cleaning products
41. Propylene dichloride	perchlorethylene carbon tetrachloride

Table 3-13 Continued

Petrochemical Type	Products or Use
42. Propylene glycol	pet food
43. Resins	canoes fiberglass bath fixtures no. 2 fuel oil
44. S-4 stabilizers	film developer
45. Satisol	solvents
46. Shell sand	
47. Shrink wrap	packaging
48. Solvents	lacquer thinner MIL-H-5606 methyl ethyl ketone naptha, printing, tolvol, xylol, pneumatic tires
49. Stanisal	solvents telephone set repair
50. Super napthalite	cleaning products
51. Tetraethyl lead	gasoline
52. Thinners	conveyors telephone set repair
53. White petroleum	a

a) Not given

Table 3-14

PETROCHEMICAL REQUIREMENTS, KANSAS, 1973-74

Petrochemical Type	Average Monthly Requirement
A-10 Activator	27 Gals.
Adhesive	6,730 Lbs.
Alcohol	74,017 Gals.
Extenders	1,812,577 Gals.
Hexane	119,794 Lbs.
Icobutane	136,363 Lbs.
Liquid Fix	27 Gals.
Liquidlith	188 Gals.
Methanol	1,183,242 Gals.
Methyl Ethyl Ketone	40,703 Lbs.
Methyl Isoampyle Ketone	20,809 Gals.
Methylene Chloride	740 Gals.
Mineral Seal Oil	188,036 Lbs.
Mineral Spirits	57,218 Gals.
P.M.T.	13 Gals.
Paints	20,190 Gals.
Parafin	174,980 Lbs.
Petrodistillate	11,468 Gals.
Phenol	865,178 Gals.
Plastics	19,706,086 Lbs.
Polybutyldiene	403,800 Lbs.
Polyethylene	5,320,227 Lbs.
Polypropylene	26,920 Lbs.
Polystyrene	1,346,000 Lbs.
Propylene Dichloride	12,114 Tons
Propylene Glycol	26,920 Lbs.
Resins	538,400 Lbs.
S-4 Stabilizers	27 Gals.
Satisol	135 Gals.
Shrink Wrap	6,370 Lbs.
Solvents	4,421,677 Gals.
Stanisol	511 Gals.
Super Napthalite	7,672 Lbs.
Tetraethyl Lead	7,053,040 Lbs.
Thinners	982,418 Gals.
White Petroleum	431 Lbs.

firms. No attempt was made to give a detailed analysis of petrochemical use in Kansas due to the technical nature of the subject matter. The tables mentioned above were presented only to illustrate the widespread usage of petrochemicals in the economy.

CHAPTER IV

CONVERSION OF PRIMARY FUEL SYSTEMS TO ALTERNATE ENERGY SOURCES

One response to the energy crisis, and in particular to increased natural gas service curtailments, was conversion of the primary fuel system to an alternate energy source. Few firms were expected to have definite conversion plans from oil to another fuel because such changes are typically long run in nature. Sufficient time had not elapsed since the oil embargo of 1973 to allow for widespread replacement of oil-fired capital equipment. Due to the relatively high initial cost of conversion and long life of the equipment, conversion would be expected to occur gradually over an extended period of time. In addition, uncertainty about future relative prices and availabilities of the various energy sources could cause firms to delay such decisions.

Only six of the sample firms, 3.6 percent, had definite plans to convert their primary fuel systems to accept an alternate fuel. If a 3 percent to 5 percent replacement rate were considered normal (assuming equipment life of twenty to thirty years), then a 3.6 percent conversion rate, as opposed to normal replacement, appears more significant. The interesting aspect of the six firms' conversion plans was that

they all involved a switch from natural gas to another energy source: coal, oil, electricity, or wood.

Within the lumber and wood products industry, one firm planned a change to wood-burning, at an estimated cost of approximately $300,000. In printing and publishing, one company had already converted to electricity. Among the chemical firms, one planned a change to coal at a cost of $500,000; another firm was undecided about a similar conversion and one company claimed that it was unable to convert. One rubber and plastic products firm planned a changeover to coal. Within the stone, clay and glass products industry, one firm decided to change to fuel oil, and another firm's system was already interchangeable with fuel oil. In the machinery, except electrical industry, one company was undecided about converting; they were investigating two possibilities. Their estimated costs of conversion were: coal-- $1,000,000; electricity-- $500,000. One transportation equipment firm was changing to coal at an estimated cost of $300,000. In the finance, insurance, and real estate industry, one company was changing to electricity. Several firms cited financial problems or difficulties in meeting pollution standards as reasons for their inability to convert to other energy sources.

Natural gas was the main source of energy for manufacturing and commercial firms in Kansas, with the exception of trade and finance. The planned conversions from natural gas to other

fuels or to electricity was probably the result of two things: expectations of higher relative prices of natural gas and increased interruptions of service. Myers found that most of the firms he surveyed expected natural gas prices to rise faster than prices of other energy sources.[63] He also found that "anticipations of a greater degree of interruption of gas supply are more prevalent than expectations of specific and outright limitations on yearly supply."[64]

Before a firm can convert from natural gas to another fuel, several problems must be overcome. First, there are physical requirements. Piped natural gas requires no storage room, but coal, fuel oil, and LPG do. Also, gas equipment, particularly in metal and machinery plants, is very common; equipment for alternate fuels may be uncommon or unproven.[65] For some industries, only certain fuels are acceptable. In heat treating furnaces that surface harden or form protective coatings, oil and coal are unsuitable; only propane is a theoretical substitute where purity is important for controlled atmosphere. Certain neutral gases such as carbon dioxide or nitrogen could possibly be used indirectly for such applications.[66] Within the glass and clay manufacturing industry, oil is generally an unacceptable substitute for natural gas, because oil either "produces a 'bloom' on the product which interferes with subsequent processing, discolors it, or adversely affects its physical properties."[67]

Second, there are investment requirements to be met. The savings expected from conversion must at least cover the investment cost within the pay-back period satisfactory to management. Firms interviewed by National Economic Research Associates required a pay-back period of from one to five years.[68] However, this is not a sufficient reason to convert. A firm may have problems financing the changeover, or, if adequate finances are available, may have alternate investment possibilities with greater expected profitability.

Certain external factors must also be taken into consideration. Government regulation is a primary example. State and local regulations, including zoning rules, may prevent large scale storage of hazardous materials such as propane and LPG. A more commonly recognized problem is that of meeting air quality standards. The main difficulties with coal are restrictions or regulations on its use, for environmental reasons. "For example, 80% of coal users... in stone, clay, and glass, 70% of users in food, and 50% of users in chemicals anticipate problems of this nature between now and 1980."[69] Users of residual fuel oils also expect some difficulties due to environmental regulations, but fewer problems are expected in obtaining and using distillate oils.[70] The regulations are intended to deal with the high sulfur content of coal from the East and Midwest. Western coal, although low in sulfur, is also relatively low in heat content.[71]

Another consideration, external to the firm, concerns the competitive position of the firm. If a particular fuel mix is common throughout the industry, a national wellhead price increase for natural gas or increased service interruptions for all firms, may have simlar impacts on all. Then perhaps, only the marginally profitable operations would have to convert, while other firms could be reluctant to act until others in the industry do so. Regional price and availability changes are more likely to affect a plant's competitive position.[72]

The conversions which were planned by Kansas firms between 1973 and 1974 had one common characteristic: each of the firms was changing from natural gas to another fuel. All of the manufacturing firms had experienced increases in curtailments of natural gas service between 1970 and May 1974. These conversions were probably, at least in part, prompted by the increased interruptions rather than by the oil embargo and subsequent oil price increases. However, only one firm planned a change to fuel oil, so the oil crisis may have influenced the choice of alternate fuels. Rapid and extensive conversions would not be expected due to the physical and investment requirements, environmental considerations, and uncertainty concerning future prices and availabilities of fuels.

CHAPTER V

CONSERVATION PRACTICES OF COMMERCIAL AND INDUSTRIAL FIRMS

The most likely short run response to the energy crisis by commercial and industrial firms was expected to be the adoption of energy-saving techniques. Such conservation efforts would have lower capital costs and shorter implementation time than either conversion or increased standby fuel storage facilities. In addition, virtually no adverse environmental effects would result from energy management programs. These advantages pointed to conservation as the most effective short run reaction to the energy crisis.

Part IV of the questionnaire was designed to investigate the effectiveness of conservation efforts undertaken by firms in Kansas after November 1, 1973. The firms were asked to list the specific energy conservation measures adopted, the fuel type saved, and the percent reduction achieved in requirements for that fuel. The responses which resulted included a large array of energy-saving techniques, many of which were specific to the industry or production process involved. It was necessary to sacrifice some level of detail to obtain an overview of the nature of the conservation effort and its results.

The conservation practices of Kansas firms were divided into seven basic categories: (1) "Reduced lighting" included use of lower watt bulbs or high pressure lamps, elimination of advertising lights, and reduced exterior lighting such as in parking lots; (2) "Improved insulation" referred to the building itself (walls, doors, and windows), duct work, steam pipes, refrigeration lines, and to insulation of tanks and coolers, erection of windscreens, etc.; (3) "Reduced fuel requirements for space heating or cooling" included altered thermostat settings, reduced heated area, discontinued use of portable heaters, reduction of fresh air mix, heat or fuel reclamation, and new or improved heating or cooling systems; (4) "Efficient vehicle usage" encompassed tuning engines more frequently, installing radial tires, using fuel additives, lowering speed limits for company vehicles, car pooling, better traffic routing, and changing to electric trucks; (5) "Improved process efficiency" consisted of shutting down equipment not in use, preventive maintenance and repair, reduced boiler pressure, installation of infiltration barriers, preheating systems, or other new manufacturing equipment which uses energy more efficiently; (6) "Process curtailment" included shorter business hours, altered production schedules and decreased production when on standby fuel; (7) "Compliance with voluntary and mandatory government programs" included energy management under the Voluntary

Industrial Energy Conservation Program initiated in 1974.

Virtually, all of the sample firms reported taking some measures to conserve energy. The most frequently cited practices were the "housekeeping" measures, namely, numbers one through three listed above.

Average percent reductions were calculated for each fuel under each measure and were weighted by participation rates. Many firmsdid not specify whether the percentage should be applied to energy requirements for that particular end use, to their "commercial" or "industrial" energy consumption, or to their entire usage of the fuel in question. Therefore, this chapter presents three conservation scenarios, one for each of these possibilities. These are illustrated in Table 5-1. Judging from the magnitude of the individual percentage reductions, it appeared that most firms in both the commercial and industrial sectors were reporting decreases in their total requirements, in most cases. The high scenario resulted in an 8.6 percent decrease in net natural gas requirements, a 6.5 percent savings in electricity consumption, an 11.2 percent decrease in coal use, a 0.4 percent drop in net distillate oil consumption, a 1.9 percent decrease in net residual fuel oil use, and a 1.8 percent savings of LPG. In total net BTU terms, the effect of conservation practices among Kansas commercial and industrial firms was 8.4 percent between 1973 and 1974. Table 5-2 shows the savings achieved by fuel for each measure.

Table 5-1

Table 5-1

CONSERVATION SCENARIOS FOR KANSAS COMMERCIAL AND INDUSTRIAL FIRMS, 1973-74

Scenario	Sector	Natural Gas (MMCF)	Electricity (GWH)	Coal & Coke (Thou.S.T.)	Distillate & Kerosene (TBTU)	Residual Fuel Oil (TBTU)	LPG (TBTU)
Low	Commercial	4,012.6	132.8	0.0	89.6	0.0	32.4
	Industrial	9,841.3	93.3	22.8	31.3	142.2	40.4
	Total	13,853.9	226.1	22.8	120.9	142.2	72.8
Medium	Commercial	4,602.6	335.8	0.0	128.8	0.0	32.4
	Industrial	10,358.5	98.8	22.8	32.8	159.2	148.3
	Total	14,961.1	434.6	22.8	161.6	159.2	180.7
High	Commercial	20,209.3	364.8	0.0	128.8	0.0	32.4
	Industrial	14,024.3	305.3	27.4	98.4	202.7	193.0
	Total	34,233.6	670.1	27.4	227.2	202.7	225.4

Table 5-2

CONSERVATION IN THE COMMERCIAL-INDUSTRIAL SECTOR, 1973-74

Conservation Measure	Natural Gas (MMCF)	Electricity (GWH)	Coal & Coke (Thou.S.T.)	Distillate Oil, Kerosene (TBTU)	Residual Fuel Oil (TBTU)	LPG (TBTU)
Reduced lighting	....	183.8	....	....	....	....
Reduced space conditioning requirements	24,891.2	425.5	2.6	77.5	170.1	170.5
Process improvements	8,704.7	49.2	24.8	138.6	27.2	23.9
Maintenance	181.0	1.5	....	....	5.4	6.4
Process or hours curtailment	149.5	9.9	....	....	....	....
Efficient vehicle or materials handling equipment usage	....	....	....	11.1	....	24.6
Compliance with government program	307.2	0.2	....	....	....	....
Total	34,233.6	670.1	27.4	227.2	202.7	225.4

The commercial sector was responsible for 57 percent of the savings, primarily due to reduced space conditioning requirements for natural gas. Table 5-3 illustrates the effect of conservation measures undertaken by commercial firms. For fuels common to both the commercial and industrial firms, the commercial ones saved more of each except LPG.

Most of the industrial firms' energy savings were of natural gas, due to process improvements and reduced space conditioning requirements. Electricity consumption showed the second largest absolute decline, as in the commercial sector. This reduction was achieved through reduced space conditioning and lighting requirements. Table 5-4 shows the conservation practices and energy savings for each fuel for the industrial firms.

The savings estimated by this study were consistent with the actual and potential reductions found in much of the literature. For example, Abelson found that good energy management practices cut consumption by as much as 25 percent in some firms, and that a 10 to 15 percent drop was common.[73] If participation rates were applied to Abelson's findings, the savings achieved would be somewhat lower, as in this study's estimates.

Two major causes of energy waste at the point of consumption, according to Berg, have been faulty heat transfer and mixing, and deterioration of equipment through lax maintenance.[74]

Table 5-3

CONSERVATION IN THE COMMERCIAL SECTOR, 1973-74

Conservation Measure	Natural Gas (MMCF)	Electricity (GWH)	Distillate Fuel Oil & Kerosene (TBTU)	LPG (TBTU)
Reduced lighting	....	135.7	....	....
Reduced space conditioning requirements	20,077.7	218.8	0.1	....
Process improvements	108.7	6.8	117.6	12.2
Process or hours curtailment	22.9	3.5	....	....
Efficient vehicle or materials handling equipment usage	....	....	11.1	20.2
Total	20,209.3	364.8	128.8	32.4

Table 5-4

CONSERVATION IN THE INDUSTRIAL SECTOR, 1973-74

Conservation Measure	Natural Gas (MMCF)	Electricity (GWH)	Coal & Coke (Thou.S.T.)	Distillate Fuel Oil & Kerosene (TBTU)	Residual Fuel Oil (TBTU)	LPG (TBTU)
Reduced lighting	....	48.1	....	....	....	....
Reduced space conditioning requirements	4,813.5	206.7	2.6	77.4	170.1	170.1
Process improvements	8,596.0	42.4	24.8	21.0	27.2	11.7
Maintenance	181.0	1.5	....	....	....	....
Process or hours curtailment	126.6	6.4	....	....	....	....
Efficient vehicle or materials handling equipment usage	....	....	....	....	....	4.4
Compliance with government program	307.2	0.2	....	....	....	....
Total	14,024.3	305.3	27.4	98.4	202.7	193.0

Therefore, general "housekeeping" measures and preventive maintenance and repair could eliminate much of the energy waste at the point of energy consumption, particularly for the space heating, process steam, and direct heat end uses. Berg's findings indicated that improved energy management practices in these areas have resulted in 7 to 15 percent savings in the fuel requirements of large industrial plants.[75] For similar plants, the Federal Power Commission stated that industry professionals estimate 20 percent reductions in consumption are possible without a sacrifice of plant output.[76]

Other "housekeeping" measures which could be adopted by most firms apply to the universal end use -- lighting. Environmental Analysts, Inc., stated that a range of 10 to 25 percent savings was usually attained in commercial lighting by (1) using lighting levels appropriate for the activity, (2) changing to fluorescent fixtures, (3) using lighter finishes on walls, and (4) turning off lights when they are not needed.[77] When weighted by participation rates, savings in the area of lighting ranged from 1 to 7 percent for various industries in Kansas.

The largest energy consumers in the ten most energy intensive industries in the nation reported their estimated energy savings to the Federal Energy Administration under the Voluntary Industrial Energy Conservation Program initiated in 1974. The Energy Policy and Conservation Act of 1975 required these firms to report their progress toward the

industrial energy efficiency targets set by the Federal Energy Administration (U.S. Department of Energy) for 1980. The savings achieved by the end of 1976, calculated on a base year of 1972, were as follows:[78]

Industry	Percent Savings
Chemicals	9.1
Primary metals	3.8
Petroleum and coal	12.2
Stone, clay, and glass	7.3
Paper	9.3
Food	11.4
Fabricated metals	3.8
Transportation equipment	12.2
Machinery, except electrical	16.8
Textiles	11.2

The savings estimated by the sample firms of these industries in Kansas are not strictly comparable because (1) they were not necessarily computed by the methodology prescribed by the government, (2) the time periods differ, (3) the sample firms are generally smaller than those required to report conservation efforts to the government agency, and (4) the industrial mix in Kansas with a given two-digit Standard Industrial Classification may differ from that reporting to the agency. The energy savings estimated in this study for the same ten industries between 1973 and 1974 were the following:

Industry	Percent Savings
Chemicals	9.1
Primary metals	11.7
Petroleum and coal	3.1
Stone, clay, and glass	12.8

Industry	Percent Savings
Paper	10.5
Food	4.8
Fabricated metals	5.5
Transportation equipment	10.4
Machinery, except electrical	7.3
Textiles	2.9

Investigation of the conservation efforts of Kansas firms between 1973 and 1974 confirmed that such efforts were the most common short run response to the energy crisis. Virtually all of the sample firms adopted at least some energy-saving measures. The most frequently cited techniques were of the "housekeeping" variety, although manufacturing firms did report some process changes. The measures undertaken by the commercial and industrial firms resulted in savings of approximately 8.4 percent of the 1973 total net BTU requirements. The commercial sector was responsible for the majority of the decrease, which was primarily due to reduced space conditioning energy requirements.

It should be noted that energy conservation is difficult to measure for a number of reasons. Changes in weather, product mix, output levels, plant or office size, hours of operation, etc., can all affect the energy consumption of firms. Therefore, an estimate of savings over what would otherwise have been used is not easily obtained. Estimates in this study, as well as those reported in the literature, are affected by the ability of the firm to identify the impact of a conservation effort.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this study was to provide information concerning the energy consumption patterns of Kansas commercial and industrial firms. Primary objectives included an analysis of end uses for each energy source and an assessment of the firms' reactions to the energy crisis, particularly conversion plans and conservation practices.

Energy Consumption

The commercial-industrial sector in Kansas was found to rely heavily upon natural gas, which accounted for over 60 percent of net energy consumption. Fuel oils and other petroleum products were the second most important energy source, particlarly among the commercial firms. Within manufacturing, the dominant energy users were the food, furniture, chemical, petroleum, rubber, stone, clay, and glass, and transportation equipment industries.

Given the reliance on natural gas in Kansas, and the fact that almost 75 percent of the gas sold to manufacturing was interruptible, curtailments are an important aspect of energy consumption. The number of hours that service was curtailed rose considerably between 1970 and 1974. Such service interruptions can be costly, resulting in greater fuel

oil consumption on standby equipment or in temporarily discontinued production. Changing to firm gas service is generally too expensive to be a realistic alternative. The reaction of some of the more energy intensive firms has been to increase storage capacities for standby fuel oil systems.

Among the commercial end uses of energy, space conditioning and lighting accounted for the highest percentages of total BTU consumption. For natural gas, fuel oil, and coal, the major end use was space heating. Lighting and air conditioning were the dominant uses of electricity, while materials handling equipment took a larger share of LPG than space heating. Where it is deemed desirable to decrease commercial energy use, concentration on these end uses would be fruitful.

The pattern of industrial end uses in Kansas differed from regional and national distributions because energy consumed for pumping and dredging by the mining firms was so great. Excluding this end use, 41.4 percent of the net energy usage was to provide process steam and 52.3 percent for direct heat. Therefore, process changes would be required to lessen energy consumption in industrial applications by any significant amount.

In the areas of energy consumption and end use analysis, further study of petrochemicals is necessary. Two important industries are Standard Industrial Classification Code (SIC) 2815, which produces cyclic intermediates, and

SIC 2819, which produces acyclic hydrocarbons. The main product of the former is cyclic organic intermediates made from petrochemical feedstocks. These outputs, which include cyclohexane, phenols, and styrenes, are sold to plastics and synthetic fibers industries. The latter (organic chemicals) industry produces derivatives of petroleum and gas which are, in turn, inputs to a variety of other industries: plastics, synthetic fibers, synthetic rubber, fertilizer, pesticides, detergents, solvents, and gasoline.[79] The use of petrochemicals is so pervasive that research in this area would be desirable.

Conversion to Alternate Energy Sources

All of the conversions in Kansas were from natural gas to another energy source. Increases in natural gas prices and in curtailments are sufficient reasons to consider converting to another primary fuel, or to electricity, but few firms have actually made definite plans to change. There are several reasons to delay such plans, which may involve considerable capital investment. First, the firms are uncertain about the paths of future energy prices, and about the availability of nonrenewable fuels. Many of the firms using interruptible gas already have the capability to burn fuel oil. Thus the easy change would be to fuel oil, yet the question of future price and supply remains. In addition, the firms may have physical space limitations for storage of oil. The second consideration is the estimated

cost of conversion, which must be compared with possible fuel cost savings as well as with the alternate investment possibilities. A third reason to delay concerns environmental regulations which affect both residual fuel oil and coal burning operations. Compliance with environmental standards increases both capital and maintenance costs associated with these fuels. With no alternative clearly better than the present mode of production, it is unlikely that many firms will convert. Interruptible natural gas is still relatively inexpensive, free of pollution-causing agents, and requires no storage facilities. The popular solution is to maintain and increase standby fuel stocks, and to adopt energy conservation measures.

Conservation Practices

The most effective short run policy has been conservation, for many reasons. It is less costly to implement a good energy management program than to convert a fuel system or replace buildings and entire production facilities. It is also easier and produces results sooner than more drastic methods of decreasing consumption. Other advantages are the reduction of pollution merely by decreasing the quantity of fuel burned, and the fact that unknown adverse impacts are very unlikely.

As noted in the end use analysis, space conditioning and lighting offer the most opportunities for significant savings in commercial consumption. The decrease in space

conditioning requirements in Kansas amounted to 26,526 TBTU, which was approximately 71 percent of the total conservation effect and 5.2 percent of total net energy consumption. Reduced lighting requirements only represented 1.6 percent of the entire savings due to conservation.

Energy savings in the industrial uses were mainly due to process improvements by manufacturing firms. These decreases in consumption equalled 9,561 TBTU, and represented 25.5 percent of the conservation impact, but only 1.8 percent of total net energy requirements of commercial and industrial firms. These technological changes were perhaps accelerated by the "energy crisis," but are really a continuation of a long trend. In Myer's study of twenty-nine energy intensive industries, only seven showed increases in energy used per dollar of output between 1947 and 1967. Of the ones showing past increases in energy per output, five were predicted to exhibit further increases between 1967 and 1980. These industries were prepared foods, synthetic rubber, ready-mixed concrete, electrometallurgical products, and steel foundries.

Two other industries which had shown increased energy efficiency in the past were forecasted to use more energy per output in the future: building paper and board mills and gray iron.[80]

Given the recent trends of increased energy prices, natural gas curtailments, and fears of oil supply problems,

the energy per unit output ratios of manufacturing firms will probably continue to decline. Exceptions may occur due to shifts toward a more energy intensive product mix in some industries.[81]

The short run reaction to the "energy crisis" by Kansas commercial and industrial firms then, has primarily been confined to adoption of conservation practices. Included have been measures to reduce space conditioning energy requirements, especially by the commercial sector, and more rapid implementation of technological changes by the industrial sector to decrease energy used per unit of output.

APPENDIX

Table A-1. QUESTIONNAIRE SENT TO SAMPLE FIRMS

I. ENERGY PRODUCT REQUIREMENTS OF YOUR FIRM

	1973				1974					
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Jan.	Feb.	Mar.	Apr.	May	June
Natural Gas (1,000's cu. ft.)										
Fuel Oil-Gallons (specify grade)										
LPG - Gallons										
Electricity (KWH)										
Coal - Tons										

If your firm utilizes natural gas as a primary fuel source, is service agreement with your gas supplier interruptible? Yes_____ No_____

If the answer to the above question is "Yes" to what degree was service curtailed in:

1970_____ 1973_____

1971_____ 1974_____ (Jan.-May)

1972_____

(Indicate total number of hours curtailed for each year listed).

Does your firm have a standby system capable of utilizing an alternate fuel?
Yes_____ No_____

If so, what type of standby fuel do you use? _____

What is your storage capacity for standby fuel? (Please indicate volume and its equivalency in days' supply) _____

Do you plan to increase storage capacity for standby fuel? Yes_____

No _____

If so, by how much? _____

Does your firm have any plans to permanently convert your primary fuel system from use of one type of fuel to another? (For example, from use of natural gas to coal or electricity). Yes_____ No_____

If so, please explain: _____

_____

Estimated cost of conversion: _____

II. PETROCHEMICAL REQUIREMENTS (for Manufacturers only)

Does your firm require the direct use of any petrochemicals in the manufacture of products? Yes_____ No_____

If so, please list the type(s) of petrochemical(s) needed for manufacture of what products, and the average monthly quantity required:

Petrochemical Type	Product	Average Monthly Requirement

III. ENERGY USE

Please give percentage estimates on how each of the listed fuel types are used on an annual basis by your firm. (All firms complete Part A. Manufacturing firms complete Parts A and B.)

A. COMMERCIAL (sales, service, administration, etc.)

Use Category	Natural Gas	Fuel Oil	LPG's	Electricity	Coal
Other (please specify)					
TOTAL	100%	100%	100%	100%	100%

B. INDUSTRIAL (manufacturing, processing, etc.)

Use Category	Natural Gas	Fuel Oil	LPG's	Electricity	Coal
Other (please specify)					
TOTAL	100%	100%	100%	100%	100%

IV. ENERGY CONSERVATION

Please identify conservation efforts undertaken by your firm since November 1, 1973. Indicate the specific conservation measure, the fuel type saved, and the estimated energy savings attributable to the conservation measure.

Energy Conservation Measure[1]	Fuel Typed Saved[2]	Energy Savings[3]

1) Improved insulation, altered thermostat settings, reduced lighting, etc.

2) Natural gas, electricity, fuel oil, etc.

3) Per cent reduction achieved in requirements for fuel type listed in Column 2.

V. COMPANY INFORMATION

Average 1973 Employment _____

1973 Sales _____

Name of Company _____

Name and/or Title of Person Completing Form _____

The preparation of this questionnaire was financed in part through a comprehensive planning grant from the Department of Housing and Urban Development of Economic Development.

FOOTNOTES

1. John E. Gray, Energy Policy: Industry Perspectives (Cambridge: Ballinger Publishing Company, 1975), p.8.

2. R. Thomas Van Arsdall, Regional Patterns of Energy Consumption in the U.S. 1967 (Urbana, Illinois: Center for Advanced Computation, University of Illinois at Urbana-Champaign, January, 1975), p. 1.

3. An "End Use" is the final point of consumption, i.e., space heat, water heating, process steam, etc.

4. "Gross energy consumption" includes fuel used to generate electricity; this fuel is included within the transportation, communications, and sanitary services industry group.

5. U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, States and Areas 1939-74, Bulletin 1370-11 (1975), pp. 277-282.

6. U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1973, United States, CBP-73-1, pp. 53-54.

7. Idem, Annual Survey of Manufactures, 1973, M73(AS)-6, p. 114.

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9. Idem, Annual Survey of Manufactures, 1975, Fuels and Electric Energy Consumed, M75(AS)-4, pp. 82-85; Idem, Annual Survey of Manufactures, 1974, Fuels and Electric Energy Consumed, M74(AS)-4.2, pp. 22-23, 84-87 and 136.

10. Idem, Annual Survey of Manufactures, 1975, M75(AS)-6, pp. 115-121; Idem, Annual Survey of Manufactures, 1973, M73(AS)-6, p. 114; Idem, 1972 Census of Manufactures, Vol. III Area Statistics, Part 1. Alabama-Montana, Kansas, Table 5.

11. M. Jarvin Emerson, Provisional Energy Demand Estimates for Kansas Industries, a draft report for the Kansas Department of Economic Development (1973).

12. American Gas Association, 1973 Gas Facts, (Arlington, Virginia: American Gas Association, 1974), p. 79.

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ENERGY CONSUMPTION, CONVERSION PLANS, AND CONSERVATION IN KANSAS COMMERCIAL AND INDUSTRIAL FIRMS

by

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B.A., University of Cincinnati, 1972

An Abstract of a Master's Thesis

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1979

Information concerning energy consumption by firms within the commercial-industrial sector at the state level has been very limited. Rising energy prices and potentially limited availability of certain fuels have increased public awareness of the importance of primary fuels in the economy, but the lack of regional and state data poses a problem for both private industry and government policy makers. An accurate picture of post-embargo energy consumption patterns, as well as an assessment of firms' reactions to the "energy crisis" is needed.

A questionnaire sent to a sample of Kansas commercial and industrial firms is the primary data source for this study of consumption patterns by industry. Annual gross and net consumption are estimated for seven major fuels and twenty-three industries for 1973. Natural gas is found to be the major primary fuel, accounting for over 60 percent of total net energy requirements of the sector. Fuel oils and other petroleum products are the second most important energy source, especially among the commercial firms. The dominant energy users within manufacturing are the food, furniture, chemical, petroleum, rubber, stone, clay and glass, and transportation equipment producers.

Curtailments of interruptible natural gas service and changes in relative fuel prices and availabilities have led some firms to increase standby fuel storage capabilities or to convert primary fuel systems to accept an alternate energy

source. The majority of firms, however, have made no definite conversion plans due to the capital costs involved, uncertainties regarding future energy prices and supplies, and difficulties in meeting environmental standards.

Among the commercial end uses of energy, space conditioning and lighting account for the highest percentages of total net BTU consumption. The primary use of natural gas, coal, and fuel oils is space heating. Electricity is mainly required for lighting and air conditioning, and LPG for materials handling equipment. The pattern of commercial end uses, in terms of total net BTU consumption, is very similar to that found in the West North Central region and in the United States as a whole.

The distribution of net energy requirements among industrial end uses differs from that found in the region and the nation due to the unusually large quantities of natural gas used by mining firms for pumping and dredging. The other major industrial end uses are direct heat and process steam. Natural gas represents nearly 89 percent of industrial net energy consumption, and approximately 75 percent of industrial gas service is interruptible.

The short run reaction of the majority of Kansas firms to the "energy crisis" has been conservation. The most frequently mentioned measures are reductions in lighting and space conditioning energy requirements and improved production processes. The overall effect of adopting conservation practices is estimated to be an 8 percent reduction in net energy requirements of the commercial-industrial sector between 1973 and 1974.