STATE OF ILLINOIS
HENRY HORNER, GOVERNOR
DEPARTMENT OF REGISTRATION AND EDUCATION
DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

BULLETIN No. 63

The Competitive Position of Illinois Coal in the Illinois Coal Market Area

WALTER H. VOSKUIL

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS
1936

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The Competitive Position of Illinois Coal in the Illinois Coal Market Area

WALTER H. VOSKUIL

CHAPTER I

A SURVEY OF THE MARKET FOR ILLINOIS COAL

ILLINOIS SUPPLIES COAL to seven states in the Upper Mississippi Valley—Illinois, Wisconsin, Minnesota, Iowa, Missouri, the Dakotas and portions of Nebraska and Kansas. In this same area also are marketed vast quantities of coal from West Virginia, Kentucky, Pennsylvania, and elsewhere, fuel oil from local refineries and from Mid-Continent plants, and natural gas from Kansas, Louisiana, and the Panhandle of Texas. This Upper Mississippi Valley is a battle ground for competing fuels from widely separated regional sources. Each fuel industry is equipped and prepared to supply a far greater quantity of fuel in its own normal market than the market requires.

NEED OF AN ANALYSIS OF ENERGY CONSUMPTION

Many producers of Illinois coal desire an analysis of the energy consumption in the Illinois coal market area, the extent and capacity of the energy market, the contribution made by each of the several energy sources, the past and present trends, and the competitive position of each fuel. Such an analysis is a necessary step to the formulation of an intelligent program of preparation of materials for the market and of marketing these materials. Unnecessary expenditures can be avoided and more effective practices can be undertaken. Such an analysis will also shed light on needed forms of cooperation among producers, on needed harmonious relations between employers and employees, on needed closer relations between producers and consumers of coal, on ways to improve marketing practice by retail dealers and finally, on the merits of proposed legislative measures with reference to public welfare.

DISTRIBUTION AND MARKETING PROBLEMS

Distribution and marketing will probably command the major attention of the industry in coming years. The most effective marketing methods require careful planning and thoroughly organized merchandising. Wastes will probably

be uncovered that are even larger than those which have been eliminated in production. Methods will be devised to break down distribution and selling costs and to effect more intelligent pricing. The relationships of consuming groups which have become altered will be disclosed and the areas in which the different products are supreme will be clearly recognized. Technical research will reinforce market research in improving the products for known needs, in finding needs for existing products, and in creating new products which will find new outlets. The successive step after production, namely distribution, calls for as systematic and thorough-going a regimen of research, analysis, and education as does production.

The coal industry is apparently no exception to the general law of industrial development in which three successive stages are noted. First is the phase of infancy in which the industry creeps, next comes the phase of expansion in which it runs, and third the phase of so-called stabilization or saturation in which it settles down to a steadier, more uniform pace until something new upsets the controlling factors.

Thus, instead of a straight line being representative of growth of demand for the long term, we have an "S" curve stretching across the chart of volumetric progress.

During the period from 1895 to 1918, when the coal industry stopped creeping and began to run, when the steep part of the "S" curve traced its upward course, there was little need for intensive scientific merchandising. Production was the keynote.

The close of the period of rapidly expanding markets, in 1918 and 1919, found the coal industry preparing for an ever increasing demand. The severe economic depression of 1921 was regarded as a temporary cessation in coal demand and not the beginning of a slow decline which became increasingly manifest in the intervening period from 1922 to 1929. During the severe depression from 1929 to 1934 the necessity for a study of markets and distribution problems came home to the industry.

The salvation of the coal industry lies in its having become distribution-minded. Distribution-mindedness gives rise to creative merchandising. And the extension of creative merchandising with its relatives of product research, market analysis, breakdown of sales costs, lowering of sales resistance by the determination of geographical supremacy areas, effective and intelligently selected and directed promotion, form perhaps the strongest counter force that the coal industry can set against narrowing margins of profit and decreasing volume of business.

BOUNDARIES OF THE ILLINOIS COAL MARKET AREA

The Illinois coal market area is defined as the territory included in the states of Illinois, Missouri, Iowa, Minnesota, and Wisconsin, the eastern cities of Kansas and Nebraska, and a small section of the Dakotas. The boundaries of this so defined "Illinois coal market area" are determined by competition from

other coal fields and other forms of fuel. Within the area so described 90 per cent of Illinois coal is marketed. In the southwest, fuel oil and natural gas dominate the market almost to the exclusion of coal. The westward movement of Illinois coal in Kansas, Nebraska, and the Dakotas is met by an eastward flow of coals from Colorado, Wyoming, and Montana. In the lake shore counties of Minnesota and Wisconsin, the market is dominated by Appalachian coals, cheaply carried over the Great Lakes and reaching the ports of Lake Michigan and the head of Lake Superior. Illinois coals, however, are marketed to a considerable extent in the southern and western sections of these two lake states. Only small quantities of Illinois coals are shipped east of the Illinois line. This market area is occupied almost entirely by the neighboring coal fields of Indiana and the Appalachian coal fields of Ohio, West Virginia, eastern Kentucky, and Pennsylvania.

With the above factors in mind, the map of the Illinois coal market area may be visualized. This constitutes the area which is logically and economically served by Illinois coal.

COMPETITIVE FUELS WITHIN THE ILLINOS COAL MARKET AREA

The Illinois coal market area, however, is by no means exclusively dependent upon coal from the Illinois mines. The preponderance of Appalachian coal in Wisconsin and Minnesota has been mentioned. Appalachian coal, also, moves in large tonnages into Illinois itself, particularly the Chicago district. In the States of Iowa and Missouri local coals share the market with coal imported from Illinois.

Throughout the market area, fuel oil and natural gas are also important factors in the total energy supply. Table 1 gives a summary of energy consumption in the Illinois coal market area in 1929, the year when a special distribution study was made by the U. S. Bureau of Mines. This includes coal consumption in Lake County, Indiana, as part of the Chicago fuel district.

TABLE 1.—SUMMARY OF ENERGY CONSUMPTION IN THE ILLINOIS COAL MARKET AREA IN 1929 [a]
(Exclusive of gasoline)

	Quantities	Tons or equivalent in tons of coal[b]
Coal, bituminous, tons	.....	102,858,155
Coke, tons	.....	4,580,764
Briquets, tons	.....	687,377
Anthracite, tons	.....	2,705,946
Fuel oil, barrels	28,871,165	6,880,000
Natural gas, M cubic feet	95,410,000	3,816,400
Water power, M K.W. hrs	2,814,435	2,378,000

[a] Compiled from Reports of U. S. Bureau of Mines and U. S. Geological Survey.
[b] The following ratios are used in converting fuel oil, natural gas, and water power into the equivalent of one ton of coal:
Fuel oil—4.2 bbls.
Natural gas—25,000 cu. ft.
Water power—1 kw. hr. = 1.69 pounds of coal.

MODERN CONDITIONS OF ENERGY PRODUCTION AND CONSUMPTION

Fuel resources and energy production are the bases of economic development, machine industry, transportation, and commerce in the present age. In the nineteenth century coal was the major source of energy generally available and played the leading rôle in industrial economy. In early decades of the twentieth century other sources of energy have become formidable competitors—fuel oil, gasoline, natural gas, and water power.

The history of energy utilization reveals a remarkable evolution in the relative importance and changing functions of these forms of energy. Before fuel technology attained such large significance, each of the energy groups occupied a position almost to the complete exclusion of the others. Anthracite was used principally in the field of domestic heating; bituminous coal dominated in transportation, manufacturing, and smelting; gas was used mainly for lighting and cooking; water power became associated with the infant but rapidly growing electric light and power industry.

These more or less sharply defined functions of the energy groups are tending to disappear. Fuel technology has widened the field of service for each of these energy sources so that all of them are competing more or less sharply with, and supplementing each other. The product of petroleum, e. g., fuel oil, encroaches upon the use of coal in domestic heating, water and rail transportation, gas making, central station fuel, and industrial heating. Coal, on the other hand, in a pulverized form, bids fair to assume the properties and perform the services of a liquid fuel. Water power experiences a rapid rise with the expansion of the electrical industry only to find its further expansion made difficult by the increasing efficiency and lower operating costs of the steam-electric plants.

The trend among fuels since 1900 has been marked by a rise in the relative position of fuel oil, water power, and natural gas in competition with coal. Prior to 1900 coal was the chief source of modern energy, and its consumption throughout the world was steadily increasing. Since 1913 the production of coal has increased but slowly, and a serious depression has developed in the older and more important centers of coal production. The depressed condition of the coal industry is due to a complicated series of new developments and not predominantly to any single cause.

The main causes of depression in the older coal mining regions, in spite of an increasing total consumption of world energy, are:

(a) The increase in the amount of useful energy secured from a ton of coal

(b) The competition of new coal fields

(c) The rapid expansion of the production and consumption of oil products

(d) The increasing surplus of natural gas

(e) The development of hydro-electric power

Increased output of energy from coal.—The greatest progress, in increasing the amount of useful energy secured from a ton of coal, has been the result of active research by large consumers of energy in an effort to reduce the cost of production of their services or products. Public utility companies, railroads, and producers of coke and iron and steel have been particularly active. The recovery of heat from waste gases, saving the gas from by-product coke ovens, improvements in boiler efficiency, extensive use of automatic feed and control devices, and better combustion obtained through the use of powdered coal are notable developments. The development and sale of electric power by large central plants, fuel or hydro, has been a tremendous factor in fuel economy. It has meant the elimination of a large number of small coal-burning power plants.

The average consumption of fuel of the public utility plants in the United States in 1934 was 1.45 pounds per kilowatt-hour as compared with 3.2 pounds in 1919. This alone resulted in a reduction of 40 million tons of coal requirements. It is estimated that the progress made in the past ten years in the more efficient production and use of energy for industrial purposes has meant a saving of probably at least twenty-five per cent in the fuel requirements for the delivery of the same amount of energy.

Competition of new coal fields.—Increased coal production from new fields has meant decreased output and depression in the older coal mining areas. Particularly notable has been the expansion of coal production in West Virginia, and in eastern and western Kentucky, which is reflected in a depression in the older fields of Pennsylvania, Ohio, and Illinois, and has resulted in capacity for over-production and increased competition of coal with coal.

Expansion in the use of oil products.—Fuel oils, including crude oil used direct, refinery gas oil, and fuel oil, represent the most direct competition with coal. Practically all the fuel oils are used in the production of heat and power and may be considered as filling a demand that would otherwise have been met primarily by coal. As more than sixty percent of the world output of fuel oil is consumed in the United States, it is evident that fuel oil is a factor in keeping coal production in this country at an almost stationary point.

A study of the distribution of fuel oil consumption in relation to coal production indicates that the chief use of fuel oil has developed in areas outside of the main coal producing zones, or near the points of oil refining. The present distribution of fuel oil consumption in the Illinois fuel area corresponds closely with the centers of refining. Illinois consumes approximately one-half of the total, mostly in the Chicago district. Adjacent areas, in Indiana, Wisconsin, and Michigan, use most of the remainder.

Relatively, however, fuel oil consumption in the Illinois fuel area has never been large. It now represents primarily the by-product of the local refining industries. The abundance of cheap coal has restricted fuel oil consumption to a limited number of uses in which it could find the best market. If progress in

the refining industry further tends to decrease the amount of fuel oil recovered from crude, the consumption in this region could readily adapt itself to decreasing supply. Use for domestic heating would probably be the most persistent in such an event, although the development of automatic stokers for coal-burning and the widening area of natural gas distribution may be important modifying factors.

Increasing supply of natural gas.—The consumption in the United States of 95 per cent of the world's supply of natural gas is an important factor in the competitive energy situation not found in other countries. While natural gas has long been a source of fuel in the Appalachian Field, its output there is declining, and the expansion in output in recent years has come from Louisiana, Texas, Kansas, and California. Natural gas must be distributed by pipe-line and, consequently, its competition with coal or fuel oil is limited by the radius of profitable distribution. The principal consuming areas have been in or near the oil and gas fields themselves and the largest uses have been for field operations, oil refinery fuel, and carbon black manufacture, while industrial and domestic heating consumed minor quantities. The construction of long distance pipe-lines from the Mid-Continent gas fields to Chicago, Indianapolis, and other cities of the interior states is an indication that large supplies of natural gas are available and that a new competitive factor has been added for both fuel oil and coal. The extension of the market for natural gas is so recent that it is still difficult to estimate its full effect.

Development of hydro-electric power.—The development of hydro-electric power, while showing a steady upward trend, is not important in the district served by Illinois coal. The water power installations in Wisconsin, Minnesota, Iowa, and Illinois, in their aggregate output do not exceed the equivalent of two million tons of coal annually. [1]

SUMMARY OF OBJECTIVES AND SCOPE OF THE PRESENT STUDY

The Illinois coal industry is vitally interested in this rapidly changing energy market described above. The coal fields of Illinois rank next to those of Pennsylvania and West Virginia in output, and are located in the tremendous energy-consuming market the center of which is the city of Chicago and the outer limits of which extend to the cities of eastern Kansas and Nebraska, and into the states of Missouri, Iowa, Minnesota, and Wisconsin. The market area is by no means occupied by products of the Illinois coal mines alone. It is a battle ground for the coal producers of the Appalachian and western Kentucky fields, for the fuel oil producers of the Mid-Continent fields and the natural gas of Oklahoma and Texas. The Illinois producers find their keenest competition in the Lake Dock territory from the lake-borne Appalachian coal. Crude oil and natural gas, carried by pipe line into the Chicago district, release competitive fuels in this important industrial center. The competitive struggle among the fuels has never

1 Calculated on a basis of 1.55 lbs. of coal required to produce a kilowatt-hour of electric energy.

been as keen as it is today. The future of Illinois coal rests largely in its ability to meet this competition—both of outside coals and other types of fuel—in the energy market area served by Illinois coal.

The objective of this study is to make a detailed analysis of the nature and extent of the competition from other sources of energy with the view of evaluating the economic position and outlook for the Illinois coal industry. In order to obtain a proper perspective of the place that Illinois coal occupies in the total energy demand of the area under consideration, the scope of this study must include an analysis of the energy contribution of fuel oil, natural gas, coal from outside fields, and water power, as well as the quantity of coal supplied by Illinois itself. The contribution of each of these energy sources must necessarily be reduced to a common basis of comparison, e. g., the ton of coal as basic unit and the other energy sources stated in terms of equivalents of a ton of coal.

The survey will concern itself, not only with the existing competitive situation, but also with the trends of consumption of each of the fuels over a number of years. Changes in the competitive situation among the fuels may thus be traced and the probable future trends more critically analyzed.

An important factor in the competition among coal fields is the freight rate structure. The rates on coal are determined by the Interstate Commerce Commission and are beyond the jurisdiction of competing coal fields or competing coal-carrying railroads. The fate of mining fields or entire mining districts may hang upon the decision of the commission. A study of the freight rate structure is, therefore, an essential step in understanding the competitive relationships among coal producing fields or districts.

In addition to the competitive struggle among coal fields themselves, the rise of oil and gas competition, and the controlling influence of the Interstate Commerce Commission, the coal industry cannot fail to be cognizant of the increasing efficiency in coal utilization. The latter factor is as much responsible for the flattening curves of coal consumption since 1918 as the rising tide of substitutes.

A diagnosis of the factors which stimulated both the rise of substitute fuels and the increased economy of consumption is exceedingly difficult and complex, but, no doubt, the price factor has been an important contributor. In the prewar period, with the spot price of coal averaging $1.20 at the mine, the production of bituminous coal had consistently doubled each decade. This had become an accepted performance upon which coal-company expansion and financing programs were predicated. It was inconceivable to the coal man that there could be any break in this long-established precedent. Then came an era of high prices, resulting from the disturbances of the world war. Coal prices rose from an average level of $1.20 per ton to $2.60 per ton[2] in 1916, at the mine.

This extraordinary doubling in the price of coal, almost overnight, stands without a precedent in the century-old history of the coal industry. There can

2 Shurick, A. T., Coal prices can meet competition: Forbes, April 1930, p. 19.

be little question that this acted as a powerful incentive toward economizing in the use of fuel. With coal at $2.60 per ton, there was immediate justification for large capital expenditures in fuel-economy equipment.

The various changes in energy supply and utilization indicated in this brief summary are so far reaching and complicated in their effects and interrelations that they may well be termed revolutionary. It has been the primary purpose of this introductory chapter to present an outline picture of the whole problem and to indicate the position of coal in relation to the total energy market, before proceeding to a more detailed study of the trend of coal production and consumption.

CHAPTER II

COMPETITIVE POSITION OF SOLID FUELS IN THE ILLINOIS COAL MARKET AREA

TOTAL SOLID FUELS CONSUMED IN THE ILLINOIS COAL MARKET AREA IN 1929

The Illinois coal market area consumes solid fuels of various kinds obtained from several sources within and outside of its boundaries. The principal fuel is bituminous coal, but anthracite, coke, fuel briquets, and even wood contribute to its fuel needs. The principal sources of outside fuel are the coal fields of West Virginia, Kentucky, and Pennsylvania with smaller quantities imported from Ohio and Virginia.

The total quantity of solid fuels consumed within the area in 1929, for which year detailed distribution data are available, is shown in Table 2.

TABLE 2.—SUMMARY OF SOLID FUELS USED IN THE ILLINOIS COAL MARKET AREA IN 1929 [a]
(net tons)

Fuels	*Tons*
Bituminous coal	102,858,155
Coke	4,580,764
Anthracite	2,705,946
Briquets	687,377
Total	110,832,242

[a] Illinois, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas.

THE DISTRIBUTION OF BITUMINOUS COAL IN 1929

The distribution of coal from producing field to the ultimate market is least well known of all the elements of the coal trade. The first detailed report of distribution and consumption was issued for the year 1915 by C. E. Lesher, geologist in charge of coal statistics for the U. S. Geological Survey, and published in the annual report on mineral resources.[1] Two years later, a similar report was prepared for the United States Fuel Administration in connection with the proposed allotment of bituminous coal from producing districts to consuming states.[2] Since the close of the World War the competition between the bituminous coal-producing districts in the United States for the market is yearly increas-

1 U. S. Geological Survey, Mineral Resources of the United States, 1915, Pt. II, nonmetals, pp. 433-513.
2 U. S. Geological Survey, Mineral Resources of the United States, 1917, Pt. II, nonmetals, pp. 1203-1259.

ing in severity. The extent and nature of the demand is moreover of ever-present interest to the coal industry, because more than 95 per cent of the coal produced in the United States is used within the country.

The largest problem confronting the operator of a coal mine is, of course, that of markets, and whoever produces or sells the coal must consider in a broad way the possible markets not only as to quantity but as to quality. The cost of mining, the largest element of which in most shaft mining is the cost of labor, and the cost of transportation, regulated by the Federal Government through the Interstate Commerce Commission, impose definite limitations upon the markets that may profitably be reached by any coal. A study of the movement of coal from producing field to consuming state serves to outline clearly the general market territories for each major producing field or province. Since the surveys of 1915, 1917, and 1918 were made, significant changes in production and movement have occurred so that another survey of coal distribution was desirable. Eastern and western Kentucky had risen from small beginnings to places of prominence. The origin of coal consumed in the Lake Dock territory had undergone important shifts and new coal fields played an important part in supplying the large Chicago market. Accordingly a detailed survey was undertaken by the Coal and Coke division of the U. S. Bureau of Mines under the direction of Mr. F. G. Tryon for the year 1929.

This year was chosen for analysis as being more representative of normal conditions than the depression years that followed. Table 3 presents the data selected from the U. S. Bureau of Mines reports which are of interest to the coal producers of the Illinois field. The consuming states included in this table are Illinois, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas. These states represent a more or less well defined industrial and energy consuming unit. They also represent a battle ground for coal from competitive fields, east and west, and for other fuel and energy sources, mainly fuel oil and natural gas. Illinois coal, although meeting substantial competition from fuel and energy sources derived from outside of this geographic area, finds it principal outlet in these states. The principal competition from Appalachian coal fields is in Chicago and the western Lake Michigan shore as far north as Green Bay, Wisconsin, and the Duluth-Superior coal distibuting radius. With the exception of Chicago, the Illinois coals are practically excluded from these markets. On the west the movement of Illinois coal is practically limited to the eastern cities of the Dakotas, Nebraska, and Kansas. Local coal supplies, coal from Wyoming, Colorado and Arkansas, fuel oil, and natural gas also compete in this energy market.

A movement of Illinois coal down the river to the lower Mississippi Valley states has practically disappeared with the advent of fuel oil and natural gas.

ORIGIN OF COAL CONSUMED IN THE ILLINOIS COAL MARKET AREA

Table 3 shows the origin of coal consumed in this market area by principal groups of producing fields. In view of the fact that the energy market in Nebraska and Kansas is supplied to such a large extent by fuel oil and natural gas from the Mid-Continent field as well as coal from several states outside of Illinois, two totals have been included in the table, the first of which is exclusive of these two states. On the other hand the Dakotas have been included in the first total, even though their consumption of Illinois coal is relatively small, because in these states the energy market is largely supplied by coal while fuel oil and natural gas constitute a minor factor. An examination of these totals discloses the relative importance of the various Appalachian fields as well as the distribution of coal movements by all-rail haul and over the lakes. The concentration of lake coal in Illinois (mainly Chicago), Wisconsin, and Minnesota is apparent. The advantage of low cost transportation into this part of the market is so pronounced that Illinois coal producers will find difficulty in overcoming the handicap of all-rail haul from the southern part of the State.

The wide distribution of all-rail coal from the Appalachian fields into the Illinois coal market area, however, is made in the face of higher transportation costs. This is particularly true of the New River-Winding Gulf and Pocahontas-Tug River in the low volatile fields of West Virginia, and the Kanawha, Logan, Kenova-Thacker, McRoberts, and Harlan-Benham fields in the high-volatile districts of West Virginia and eastern Kentucky. Transportation rates from these fields to Chicago vary from $3.09 to $3.29 per ton with correspondingly higher rates to points in the Illinois coal market area farther into the interior. Yet in 1929, the fields mentioned above shipped by rail 23,788,511 tons into this market area. The distribution of so large a quantity of coal is accomplished therefore upon factors other than transportation advantage. Some of this is due to demand for coal of special quality, as for example coking coals, or smokeless coals. Some of the coals find a preferential market among domestic consumers, public utilities, and railroads. Lower wages in the southern Appalachian field has been a factor in permitting an outlet for these coals in the Middle West. These factors are not of such a nature, however, that they cannot be overcome and a part of this market again returned to the coal fields of southern Illinois.

West of the Mississippi River, the Illinois coal producers find, in addition to sharing the market with the Appalachian coals, a considerable competition from local coal fields in Iowa, Missouri, and Kansas, and a smaller, though active, competition from southwestern and Rocky Mountain coal fields.

TABLE 3.—CONSUMPTION OF BITUMINOUS COAL FROM ALL SOURCES (EXCLUSIVE OF RAILWAY LOCAL

Producing State or District	Illinois[b]	Wisconsin	Minnesota
Illinois	23,148,112	846,811	767,781
Indiana	4,544,585	308,799	39,307
Western Kentucky	2,343,190	410,896	192,058
All-rail haul			
Low volatile Appalachian fields			
Central Pennsylvania	19,898	2,066	1,036
Somerset-Myersdale and Cumberland-Piedmont	32,461	4,474	3,041
New River-Winding Gulf, W. Virginia	5,649,879	337,124	132,883
Pocahontas-Tug River, W. Virginia	6,038,579	391,772	96,569
High volatile fields—Northern Appalachian			
Western Pennsylvania and W. Va. Panhandle	311,807	3,952	.....
Northern West Virginia	78,941	5,861	4,464
Northern Ohio	318	.....	.....
Southern Ohio	31,521	801	.....
High volatile fields—Mid. & So. Appalachian			
Kanawha, Logan, Kenova-Thacker, W. Virginia	2,276,104	103,671	49,556
Northeastern Kentucky, McRoberts	2,063,143	109,208	97,776
Hazard, E. Kentucky	696,527	22,064	17,301
Southeastern Kentucky, Harlan Benham	4,070,201	44,144	43,193
Virginia	173,783	20,726	17,714
Alabama	2,268	.....	.....
Lake Cargo Coal			
Upper Lake Docks	5,367,913	7,202,682	6,842,603
Western Interior and Rocky Mountain Coal			
West of Mississippi River			
Arkansas	1,895	659	96,881
Colorado	.....	.....	677
Iowa	51	.....	2,920
Kansas and Missouri	1,240	.....	654
Montana	.....	.....	8,078
North Dakota	.....	39	37,546
Oklahoma	412	102	32,133
Utah	.....	.....	.....
Wyoming	.....	.....	2,568
New Mexico	.....	.....	.....
Total	57,252,828	9,815,851	8,486,739

	Colliery fuel	Sold to local trade	Fuel for railroads
Illinois	953,932	3,991,337	20,120,355
Upper Lake Docks	.....	.....	4,219,661
Iowa	57,239	800,029	1,567,446
Kansas and Missouri	152,992	750,024	1,854,494
North Dakota	38,502	380,640	16,434
Total	1,202,665	5,922,030	27,778,390

FUELS)[a] IN THE AREA SERVED BY THE ILLINOIS COAL FIELDS (EXCLUSIVE OF COLLIERY FUEL AND TRADE) IN 1929 (Net tons)

Iowa	Missouri	North Dakota	South Dakota	Nebraska	Kansas	Total, excluding Nebraska & Kansas	Total
2,815,630	5,884,713	2,799	172,048	596,666	137,299	33,637,894	34,371,859
483,502	86,046	3,190	2,445	26,735	3,057	5,467,874	5,497,666
941,391	635,985	4,989	45,864	119,802	81	4,574,373	4,694,256
						43,680,141	44,563,781
2,731	5,026	.....	.....	1,778	1,510	30,757	34,045
1,223	1,794	384	454	319	780	43,831	44,930
84,488	97,207	.....	.....	1,176	285	6,301,581	6,303,042
67,045	7,166	.....	24,563	369	.....	7,025,694	7,026,063
						13,401,883	13,408,080
.....	.....	.....	.....	.....	.....	315,759	315,759
10,954	99	.....	2,278	226	899	102,597	103,722
.....	.....	.....	.....	.....	.....	318	318
4,921	.....	.....	.....	.....	.....	37,243	37,243
						455,917	457,042
484,230	57,450	.....	17,224	5,672	933	2,988,235	2,994,840
334,505	218,600	.....	25,235	3,356	.....	2,848,467	2,851,823
295,417	2,331	.....	3,124	1,389	4,230	1,036,764	1,042,383
436,909	9,217	.....	20,870	670	222	4,624,534	4,625,426
70,628	1,321	.....	1,616	.....	896	285,788	286,684
.....	40,256	.....	.....	.....	.....	42,524	42,524
						11,826,312	11,843,680
84,095	.....	430,654	494,769	22,330	.....	20,422,716	20,445,046
						20,422,716	20,445,046
76,534	333,880	.....	10,503	269,163	190,028	520,352	979,543
15,670	1,108	.....	50,050	866,495	525,908	67,505	1,459,908
1,704,315	190,478	.....	.....	4,235	3,639	1,897,764	1,905,638
26,182	2,358,065	.....	.....	842,757	1,054,426	2,386,141	4,283,324
2,756	.....	47,082	102,928	313	.....	160,844	161,157
29	.....	1,373,565	.....	6,223	.....	1,411,179	1,417,402
47,701	244,271	.....	4,215	211,307	350,060	328,834	890,201
84	82,986	.....	.....	35,524	24,001	83,070	142,595
20,362	2,752	15,295	194,445	588,788	21,412	235,422	845,622
.....	594	.....	.....	6,223	48,319	594	55,136
						7,091,705	12,140,526
8,011,302	10,261,345	1,817,958	1,172,631	3,611,516	2,367,985	96,878,654	102,858,155

[a] Compiled from Supplements 1, 3, 4, and 6 of the Monthly Coal Distribution Reports, August, October, November, 1931, and January, 1932, U. S. Bureau of Mines.
[b] Includes some coal shipped to the Chicago district lying in Indiana.

COAL LOCALLY USED

In addition to the coal which is shipped to consuming states by rail or lake, the coal producing states within the Illinois coal market area dispose of small quantities in coal mining localities which do not enter railway shipments, and use some in colliery operations. The total so used in 1929, as shown in Table 3, was 7,144,695 tons.

RAILWAY FUEL

In compiling statistics of coal distribution, it is necessary to show the large item of railway fuel separately as the consumption of carriers cannot be identified with a particular state. Hence the consumption of railway fuel, 27,778,390 tons, in 1929 requires interpretation. Of this total, 4,219,661 tons delivered at docks on Lakes Michigan and Superior, presumably was used mostly in the states comprising the Illinois coal market area. It is doubtful if any but a negligible quantity was carried beyond the limits of this market territory. All of this coal was, of course, received from the Appalachian fields. Distribution of Illinois coal among the railroad regions was quite widespread as shown in Table 4.

TABLE 4.—DISTRIBUTION OF ILLINOIS COAL FOR RAILROAD FUEL IN 1929 [a]

Region	Illinois	Iowa	Kansas and Missouri	North Dakota
New England	.....	.....	.....	.....
Great Lakes region	2,595,492	39,806	35,267	.....
Central Eastern region	1,820,332	.....	.....	.....
Pocahontas region	.....	.....	.....	.....
Southern region	3,276,008	.....	.....	.....
Northwestern region	4,576,962	515,015	11,879	28,911
Central western region	5,615,984	1,008,726	446,796	.....
Southwestern region	2,025,903	.....	1,364,385	.....
Total	19,910,681	1,563,547	1,858,327	28,911

[a] Distribution of Coal Shipments: U. S. Bureau of Mines, Monthly Coal Distribution Report No. 8, March, 1932, p. 7.

The railroads are normally one of the largest coal consuming groups and, as such, the trend of railway coal consumption is of vital interest to the producers. Changes that have occurred in the consumption of railway fuel are analyzed for the country as a whole in Chapter VIII.

Since the competitive position of the various coal fields lying within and without the Illinois coal market area is the resultant of the combined factors of mine price of coal, transportation costs, quality of coal, and type of consumer, a further detailed analysis of the market position of lake cargo coal, all-rail haul from the Appalachian fields and coal fields adjacent to the Illinois districts (i. e., Western Kentucky, Indiana, Iowa, Missouri, etc.) will be made separately. Before undertaking this analysis, however, a brief discussion of coke, anthracite, and briquets will be undertaken.

DISTRIBUTION OF COKE AND BRIQUETS IN 1929

The growing market for domestic by-product coke is the outstanding feature shown by the analysis of coke distribution in 1929. Ten years previous the consumption of coke for domestic purposes in the entire nation was equal to that consumed in the Illinois coal market area in 1929. Importation of coke from outside states makes up about half of the total. Presumably the major portion of this represents coke shipped from the coke ovens in Northern Indiana, although substantial quantities are also received from Alabama, Michigan, Ohio, and Pennsylvania.

Two-thirds of the fuel briquets produced in the United States are consumed in the Illinois coal market area. Nine of the twenty-four briquetting plants in operation in the United States in 1929 to 1933 are located in the Illinois coal market area. The location of the plants, the date put in operation, and the raw fuel used is given in Table 5.

TABLE 5.—BRIQUETTING PLANTS IN THE ILLINOIS COAL MARKET AREA

Location		Date put in operation	Raw fuel used, as reported by the purchaser
State	City		
Minnesota	Duluth	1933	Anthracite and bituminous slack
Missouri	Kansas City	1909	Semi-anthracite
Nebraska	Omaha	1932	Petroleum coke
North Dakota	Lehigh	1929	Lignite char
Wisconsin	Superior	1912	Bituminous slack
Wisconsin	Ashland	1931	Bituminous slack
Wisconsin	Superior	1909	Anthracite and bituminous slack
Wisconsin	Milwaukee	1928	Bituminous slack
Wisconsin	Sheboygan	1933	Bituminous slack

The briquetting industry in these states is built mainly upon the utilization of waste or by-products of the coal trade. Trans-shipment of coal over the lakes to upper lake ports results in the accumulation of slack coal and fines which would have no market otherwise. In the case of the North Dakota plant the operation is obviously based upon an attempt to improve local coals. An attempt to find a satisfactory domestic fuel to replace the high priced Pennsylvania anthracite is an important element in supporting a briquet industry in these states.

ANTHRACITE SHIPMENTS INTO THE ILLINOIS COAL MARKET AREA

Pennsylvania anthracite has been an important factor in the domestic market of the Lake Dock territory of the Illinois coal market area, but its significance appears to be declining. Shipments over the lakes since 1921 are given in Table 6.

TABLE 6.—ANTHRACITE SHIPMENTS INTO THE ILLINOIS COAL MARKET AREA [a]

Year	Loaded into vessels at Lake Erie	Receipts at Duluth—Superior
	Net tons	*Net tons*
1921	4,265,714	1,844,642
1922	1,381,946	566,362
1923	3,512,079	1,419,984
1924	3,094,088	1,289,994
1925	1,795,516	790,132
1926	2,857,917	1,272,973
1927	1,918,389	981,194
1928	1,420,882	652,095
1929	1,321,328	401,249
1930	1,232,137	460,708
1931[b]	761,000	300,000
1932[b]	294,000	66,000
1933[b]	426,000	135,000

[a] Tryon, F. G., Mann, L., and Rogers, H. O., Coal in 1930: U. S. Bureau of Mines, Mineral Resources of the United States, 1930. p. 727, 728.
[b] Minerals Yearbook, 1932-33, p. 439; 1934, p. 563.

A small quantity of anthracite included in the first column reaches Canadian ports but the item is so small as to be practically negligible. For example, in 1928, Fort William, Ontario, received 46,000 tons, and Sault Ste. Marie, 5,000 tons.

All rail shipments of anthracite from the Pennsylvania fields to the Illinois territory amounted to about 1.3 millions tons in 1929.

SUMMARY OF 1929 FUEL DISTRIBUTION

Tables 2 and 3 give a detailed picture of the movement and distribution of solid fuels in the Illinois coal market area for 1929. It should be noted that the figure of coke consumption is not altogether an additional quantity of fuel but represents, in part, a conversion into coke of coal shipped into the territory and included in Table 2. Since 1929 local changes in consumption of fuels has no doubt taken place. The broad picture, however, remains unchanged.

COAL CONSUMPTION IN THE ILLINOIS COAL MARKET AREA IN THE PERIOD 1930-1934

Since the compilation of the coal distribution data for 1929, data have been made available for the movement of coal from principal producing fields to states and important urban market centers in the Illinois coal market area. Data for coal shipments are shown in Table 7. This table shows the movement of revenue coal (exclusive of non-revenue railway fuel) from producing field to consuming state or city.

The movement of coal for the year 1932 from Illinois and competing eastern fields is shown on Plates I, II, and III (pocket). Plate I shows the shipments of coal from Illinois into the states comprising the Illinois coal market area. The influence of lake cargo coal competition is shown by the small shipments of Illinois

coal into Wisconsin, and similarly, the influence of fuel oil and natural gas is shown in the low consumption of coal in Kansas.

Plate II shows the origin and destination of railway shipments from Indiana, western Kentucky, and from the Appalachian coal fields into the Illinois coal market area. The most important contributors are the Kanawha, Logan, Kenova-Thacker, New River-Winding Gulf, and Pocahontas-Tug River fields in southern West Virginia, and the fields of Indiana and western Kentucky.

Plate III shows the origin and destination of lake cargo coal from the Appalachian fields into the Illinois coal market area. The southern Appalachian coal fields in eastern Kentucky and West Virginia are the principal contributors to the lake trade.

TABLE 7.—ORIGIN AND DESTINATION OF RAILROAD SHIPMENTS FROM ILLINOIS, INDIANA, AND

ROAD

(In net tons)

1930

From	Chicago	Illinois, Other	Milwaukee Wisconsin	Wisconsin, Other	Council Bluffs, Iowa
Western Pennsylvania	114,667	70	153	956	.....
Altoona-Somerset-Myersdale and Cumberland-Piedmont	34,969	6,664	899	11,332	745
Fairmont (W. Va.)	46,173	8,523	235	10,938	.....
Northern and Eastern Ohio	941	.....	.....	1,054	.....
Southern Ohio	25,885	1,001	51	1,721	.....
Kanawha (W. Va.), Logan and Kenova-Thacker (W. Va.-E. Ky.)	1,459,116	184,415	13,872	328,959	5,654
New River-Winding Gulf and Pocahontas-Tug River (W. Va.)	8,485,988	118,604	233,892	1,002,187	844
Northeastern Kentucky and McRoberts	1,548,414	68,468	8,726	269,768	151
Virginia	15,946	4,444	3,361	27,866	.....
Harlan and Hazard (E. Ky.)	2,958,633	511,783	5,150	296,483	3,526
Ex-River Coal	2,661	462	.....	98	.....
Northern Illinois	609,219	1,438,249	.....	20,268	1,165
Central and Southern Illinois	7,880,042	8,216,792	33,999	612,478	236,398
Indiana	2,539,635	1,173,073	25,043	233,924	7,788
Western Kentucky	699,425	798,059	3,504	316,464	103,384
1930 Total	26,421,714	12,530,607	328,885	3,134,496	359,655

1931

From	Chicago	Illinois, Other	Milwaukee, Wisconsin	Wisconsin, Other	Council Bluffs, Iowa
Western Pennsylvania	2,547	36	102	867	.....
Altoona-Somerset-Myersdale and Cumberland-Piedmont	28,903	6,561	742	2,826	505
Fairmont (W. Va.)	14,406	3,876	97	4,085	.....
Northern and Eastern Ohio	2,955	91	252	114	.....
Southern Ohio	12,498	713	.....	51	.....
Kanawha (W. Va.), Logan and Kenova-Thacker (W. Va.-E. Ky.)	1,012,870	286,945	7,108	80,004	5,329
New River-Winding Gulf and Pocahontas-Tug River (W. Va.)	6,757,346	418,998	185,069	522,990	252
Northeastern Kentucky and McRoberts	832,106	118,075	3,779	98,018	217
Virginia	18,124	12,041	1,312	21,578	.....
Harlan and Hazard (E. Ky.)	1,886,771	583,161	4,990	57,840	2,457
Ex-River Coal	8,890	102	.....	.....	.....
Northern Illinois	572,271	1,112,677	.....	9,759	1,039
Central and Southern Illinois	6,017,460	6,489,223	23,875	443,930	128,511
Indiana	2,175,249	1,035,226	17,774	250,995	7,208
Western Kentucky	594,185	506,187	3,930	293,640	36,825
1931 Total	19,936,581	10,573,912	249,030	1,786,697	182,343

[a] U. S. Bureau of Mines, Monthly Coal Distribution Report No. 1, October, 1935.

WESTERN KENTUCKY AND FROM THE APPALACHIANS (EXCLUSIVE OF NON-REVENUE RAIL-FUEL) [a]

(In net tons)

1930

Iowa, Other	St. Louis Mo.	Kansas City Mo.	St. Joseph Mo.	Missouri, Other	Kansas, Other	Nebraska, other	Minnesota	South Dakota	North Dakota
4,508	.....	.....	.....	.....	.....	.....	362	243	.....
4,208	2,374	1,828	787	2,463	1,799	1,714	4,428	1,225	.....
10,438	.....	43	.....	.....	63	41	4,157	1,469	.....
901	.....	.....	.....	.....	.....	.....	.....	.....	.....
4,459	151	.....	.....	.....	.....	.....	117	.....	.....
380,644	79,399	297	1,292	15,445	247	5,687	37,543	14,998	.....
127,465	141,813	33	100	1,634	138	540	174,160	35,870	.....
300,355	263,195	.....	.....	11,213	.....	1,550	68,454	15,004	.....
7,299	.....	.....	.....	.....	.....	.....	9,969	91	.....
638,172	2,835	.....	93	4,437	3,274	7,124	62,876	25,688	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
184,550	269	.....	.....	5,814	.....	.....	164,170	298	38
2,255,688	5,167,612	130,700	64,215	2,046,959	56,100	233,631	528,992	158,925	1,848
402,416	58,811	198	308	27,754	1,086	11,806	60,858	1,184	1,187
587,990	207,518	.....	51	360,624	56	21,654	115,260	34,777	3,507
4,909,493	5,923,977	133,099	66,846	2,476,343	62,763	283,747	1,231,346	289,772	6,580

1931

Iowa, Other	St. Louis Mo.	Kansas City Mo.	St. Joseph Mo.	Missouri, Other	Kansas, Other	Nebraska, other	Minnesota	South Dakota	North Dakota
2,752	48	.....	.....	.....	.....	.....	75	208	.....
3,011	2,235	1,585	624	1,887	1,133	1,498	4,816	1,247	.....
4,546	.....	42	.....	.....	.....	42	812	899	.....
422	.....	.....	.....	.....	.....	.....	608	.....	.....
833	.....	.....	.....	.....	.....	.....	94	.....	.....
259,149	37,427	87	170	7,761	.....	2,709	26,000	8,812	.....
96,887	122,887	74	233	1,007	96	326	182,769	28,973	.....
240,769	268,340	.....	.....	5,723	.....	1,153	56,216	19,075	.....
7,299	.....	.....	.....	.....	.....	.....	9,969	91	.....
479,405	6,030	.....	206	4,812	96	4,992	51,613	20,408	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
209,584	.....	.....	48	.....	95	.....	169,710	536	.....
1,726,758	4,095,676	75,291	32,317	1,481,701	32,862	170,692	418,866	149,214	1,361
361,668	46,708	202	343	13,695	259	8,074	95,762	1,292	136
428,655	137,235	50	.....	236,409	.....	16,752	96,089	44,397	1,865
3,821,738	4,716,586	77,331	33,941	1,752,995	34,541	206,238	1,113,399	275,152	3,362

TABLE 7 CONTINUED.—ORIGIN AND DESTINATION OF RAILROAD SHIPMENTS FROM NON-REVENUE

(In net tons)

1932

From	Chicago	Illinois, Other	Milwaukee, Wisconsin	Wisconsin, Other	Council Bluffs, Iowa
Western Pennsylvania	325	86	126	226	.....
Altoona, Somerset-Meyersdale and Cumberland-Piedmont	12,417	3,813	242	1,814	588
Fairmont (W. Va.)	14,840	1,670	1,003	2,386	.....
Northern and Eastern Ohio	1,980	.....	150	770	.....
Southern Ohio	2,596	142	.....	50	.....
Kanawha (W. Va.), Logan and Kenova-Thacker (W. Va.-E. Ky.)	825,727	178,434	4,206	70,537	3,621
New River-Winding Gulf and Pocahontas-Tug River (W. Va.)	5,942,825	375,706	158,848	535,263	202
Northeast Kentucky and McRoberts	491,950	220,571	1,479	70,290	288
Virginia	39,361	13,214	2,422	28,945	.....
Harlan and Hazard (E. Ky.)	1,030,422	514,807	4,469	60,264	1,838
Ex-River Coal	626	1,101	.....	.....	.....
Northern Illinois	603,657	1,244,808	.....	14,632	238
Central and Southern Illinois	3,862,441	5,454,889	11,297	321,495	94,237
Indiana	2,720,859	1,143,782	18,689	286,759	2,340
Western Kentucky	1,004,353	1,003,425	4,757	260,201	18,863
Total	16,554,379	10,156,448	207,688	1,653,632	122,305

1933

From	Chicago	Illinois, Other	Milwaukee, Wisconsin	Wisconsin, Other	Council Bluffs, Iowa
Western Pennsylvania	3,964	50	.....	839	32
Altoona, Somerset-Meyersdale and Cumberland-Piedmont	29,667	5,324	383	2,040	561
Fairmont (W. Va.)	17,928	1,671	306	1,982	.....
Northern and Eastern Ohio	1,175	1,526	50	2,054	.....
Southern Ohio	2,010	.....	.....	.....	.....
Kanawha (W. Va.), Logan and Kenova-Thacker (W. Va.-E. Ky.)	854,811	127,639	1,486	57,419	1,953
New River-Winding Gulf and Pocahontas-Tug River (W. Va.)	5,908,215	392,942	194,074	532,527	149
Northeast Kentucky and McRoberts	696,218	225,820	1,894	62,523	91
Virginia	56,084	14,040	490	23,710	.....
Harlan and Hazard (E. Ky.)	1,294,290	385,414	3,286	53,118	1,250
Ex-River Coal	243	51	.....	.....	.....
Northern Illinois	623,439	1,216,138	154	16,812	.....
Central and Southern Illinois	4,922,351	5,219,466	10,872	409,127	45,241
Indiana	2,701,214	995,944	28,629	336,083	651
Western Kentucky	646,009	507,085	8,178	255,947	10,183
Total	17,757,618	9,093,110	249,802	1,754,181	60,111

[a] Data from U. S. Bureau of Mines, Monthly Coal Distribution Report, No. 32, March, 1934.

ILLINOIS, INDIANA AND WESTERN KENTUCKY AND FROM THE APPALACHIANS (EXCLUSIVE OF RAILROAD FUEL) [a]

(In net tons)

1932

Iowa, Other	St. Louis Mo.	Kansas City Mo.	St. Joseph Mo.	Missouri, Other	Kansas, Other	Nebraska, other	Minnesota	South Dakota	North Dakota
1,379	102	.....	.....	.....	.....	.....	.....	.....	.....
2,435	1,602	1,317	411	2,125	1,317	1,175	3,503	1,029	.....
3,054	52	.....	.....	.....	.....	155	651	361	.....
948	.....	.....	.....	.....	.....	.....	35	.....	.....
166	.....	.....	.....	.....	.....	.....	.....	.....	.....
252,846	41,137	89	.....	4,804	89	861	27,980	4,841	.....
87,114	73,317	.....	.....	637	.....	81	223,095	32,900	.....
206,139	203,585	.....	.....	108	.....	697	46,400	6,115	.....
5,213	52	.....	.....	.....	.....	.....	9,068	461	.....
473,569	12,366	.....	48	4,044	.....	2,584	55,853	13,003	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
178,236	209	.....	.....	192	.....	32	119,518	892	75
1,295,142	2,883,363	12,739	21,707	928,259	21,504	136,741	326,604	105,697	482
303,999	70,638	101	.....	9,106	.....	7,127	124,287	2,772	148
621,262	426,477	.....	.....	287,788	240	19,662	146,432	58,895	3,392
3,431,502	3,712,900	14,246	22,166	1,237,063	23,891	169,115	1,083,426	226,966	4,097

1933

Iowa, Other	St. Louis Mo.	Kansas City Mo.	St. Joseph Mo.	Missouri, Other	Kansas, Other	Nebraska, other	Minnesota	South Dakota	North Dakota
2,647	23	.....	.....	53	.....	.....	.....	45	.....
2,786	2,074	638	248	1,846	1,199	1,278	4,223	1,149	.....
3,048	.....	.....	.....	35	.....	109	1,216	252	.....
1,870	.....	.....	.....	.....	.....	.....	238	293	.....
322	.....	.....	.....	.....	.....	.....	.....	.....	.....
208,094	42,586	43	.....	3,191	35	340	31,207	4,299	.....
86,807	65,644	.....	89	750	83	134	197,457	27,590	.....
170,380	179,463	.....	.....	868	.....	412	40,154	7,747	.....
3,986	142	.....	.....	.....	.....	.....	8,149	513	.....
425,256	11,251	.....	.....	2,750	.....	1,133	45,069	12,312	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
266,983	.....	.....	.....	.....	.....	.....	61,856	954	.....
1,288,290	2,630,143	4,343	14,759	816,659	15,202	103,930	297,789	81,235	672
282,932	60,246	105	.....	4,134	.....	5,021	137,232	18,649	584
398,858	123,562	.....	.....	152,053	.....	16,303	96,904	35,678	2,885
3,142,259	3,115,134	5,129	15,096	982,339	16,519	128,660	921,494	190,716	4,141

TABLE 7 CONTINUED.—ORIGIN AND DESTINATION OF RAILROAD SHIPMENTS FROM NON-REVENUE

(In net tons)

1934

From	Chicago	Illinois, Other	Milwaukee, Wisconsin	Wisconsin, Other	Council Bluffs, Iowa
Western Pennsylvania	19,858	1,530	340	496	.....
Altoona, Somerset-Meyersdale and Cumberland-Piedmont	31,455	4,674	413	2,586	772
Fairmont (W. Va.)	10,864	7,555	92	1,323	.....
Northern and Eastern Ohio	2,120	.....	.....	944	.....
Southern Ohio	3,201	280	.....	493	.....
Kanawha (W. Va.), Logan and Kenova-Thacker (W. Va.-E. Ky.)	865,362	105,197	1,421	42,798	1,274
New River-Winding Gulf and Pocahontas-Tug River (W. Va.)	5,987,987	417,313	122,516	534,235	77
Northeast Kentucky and McRoberts	812,537	236,818	601	43,192	.....
Virginia	86,865	14,051	.....	25,941	.....
Harlan and Hazard (E. Ky.)	1,136,387	279,383	1,513	46,481	618
Ex-River Coal	.....	248	.....	.....	.....
Northern Illinois	660,261	1,720,818	162	53,130	44
Central and Southern Illinois	5,013,206	5,697,164	16,293	665,931	42,455
Indiana	2,778,257	1,005,808	46,403	471,015	1,466
Western Kentucky	560,775	334,767	1,442	301,323	7,707
Total	17,969,135	9,825,606	191,196	2,189,888	54,413

[a] Data from U. S. Bureau of Mines, Monthly Coal Distribution Reports.

ILLINOIS, INDIANA AND WESTERN KENTUCKY AND FROM THE APPALACHIANS (EXCLUSIVE OF RAILROAD FUEL) [a]

(In net tons)

1934

Iowa, Other	St. Louis Mo.	Kansas City Mo.	St. Joseph Mo.	Missouri, Other	Kansas, Other	Nebraska, other	Minnesota	South Dakota	North Dakota
521	.....	17	.....	.....	.....	.....	172	38	.....
3,011	3,331	859	417	2,008	1,261	1,508	4,509	1,454	.....
2,313	.....	.....	.....	.....	.....	.....	475	167	.....
4,453	.....	.....	.....	.....	.....	.....	239	73	.....
487	.....	.....	.....	.....	.....	.....	100	.....	.....
179,372	42,399	.....	.....	2,819	.....	438	25,194	2,979	.....
86,465	59,558	.....	.....	681	218	393	139,063	17,995	.....
158,901	177,011	50	.....	1,737	.....	716	28,162	4,379	.....
4,142	183	.....	.....	.....	.....	.....	8,630	363	.....
375,048	6,258	.....	.....	1,820	.....	1,302	38,661	8,890	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
311,550	96	.....	.....	.....	.....	.....	50,118	1,827	.....
1,350,047	2,939,703	3,813	21,193	790,262	13,833	114,712	374,372	100,772	1,234
361,770	44,528	97	.....	1,310	.....	4,906	149,836	24,064	491
268,983	96,051	189	.....	113,548	.....	15,138	72,039	26,947	3,524
3,107,063	3,369,118	5,025	21,610	914,185	15,312	139,113	891,570	189,948	5,249

In addition to all-rail shipments into the Illinois coal market area, a substantial quantity of coal is received over the Lakes by ports on Lake Michigan and Lake Superior. Shipments to American ports on these lakes in from 1929 to 1934 are given in Table 8.

TABLE 8.—BITUMINOUS COAL SHIPMENTS TO LAKE SUPERIOR AND LAKE MICHIGAN PORTS, 1929-1934 [a]

	Superior	Michigan	Total
1934	8,569	10,912	17,481
1933	6,909	10,267	17,176
1932	6,221	7,066	13,287
1931	8,502	9,216	17,718
1930	[b]	12,056	.....
1929	[b]	12,533	.....

[a] Monthly Coal Distribution Reports, U. S. Bureau of Mines.
[b] Not available.

Although the quantities of coal distributed and consumed in this area vary from year to year and have declined substantially since 1929, the underlying conditions bringing about the distribution characteristics of 1929 have not changed appreciably.

ECONOMIC FACTORS UNDERLYING THE DISTRIBUTION OF COAL IN THE ILLINOIS COAL MARKET AREA

Several distinct coal movements must be considered in describing and analyzing the competitive position of outstanding fuels into the Illinois coal market area. The principal ones are:

(1) The rail-lake haul to the Upper Lake Dock territory.
(2) The all-rail haul from the several Appalachian coal fields in Pennsylvania, northern West Virginia, southern West Virginia, and eastern Kentucky to Chicago and other Mid-Western points.
(3) The western Kentucky movement into the southern portions of the Illinois coal market area.
(4) The eastward shipments from Rocky Mountain coal fields.

TABLE 9.—TREND OF COAL SHIPMENTS FROM THE STATES OF THE EASTERN INTERIOR COAL FIELD AND OF LAKE CARGO SHIPMENTS TO THE LAKE STATES [a]

(In thousands of net tons)

Year	Michigan	Wisconsin	Minnesota	South Dakota	North Dakota	Total	Lake cargo shipments to American ports[b]
Southern Illinois Coal to							
1923	503	2,099	2,398	254	26	5,280	
1924	336	1,564	1,340	237	15	3,492	
1925	205	1,435	1,032	225	13	2,910	
1926	344	1,246	971	226	7	2,794	
1927	59	662	629	130	3	1,483	
1928	39	738	671	151	3	1,602	
1929	35	829	768	172	3	1,807	
1930	21	667	693	159	2	1,542	
1931	8	478	589	150	1	1,226	
1932	4	347	446	107	1	905	
Indiana to							
1923	128	774	186	19	2	1,109	
1924	47	521	162	10	4	744	
1925	93	518	134	6	3	754	
1926	85	456	61	5	3	610	
1927	45	256	38	3	2	344	
1928	18	254	34	3	2	311	
1929	49	271	34	2	2	358	
1930	14	259	61	1	1	336	
1931	9	269	96	1	[c]	375	
1932	8	305	124	3	[c]	440	
Western Kentucky to							
1923	77	138	136	34	15	400	
1924	7	148	100	28	2	285	
1925	19	286	135	40	5	485	
1926	47	411	175	42	5	680	
1927	24	504	252	66	4	850	
1928	94	458	201	57	4	814	
1929	84	411	192	46	5	738	
1930	16	320	115	35	4	490	
1931	9	298	96	44	2	449	
1932	37	265	146	58	3	509	
All states to							
1923	708	3,011	2,720	307	43	6,789	24,000
1924	390	2,233	1,602	275	21	4,521	18,223
1925	317	2,239	1,301	271	21	4,149	22,125
1926	476	1,113	1,207	273	15	3,084	23,232
1927	128	1,422	919	199	9	3,777	27,586
1928	171	1,450	906	211	9	2,747	27,759
1929	168	1,511	994	220	10	2,901	31,942
1930	51	1,246	869	195	7	2,368	30,582
1931	26	1,045	781	195	3	2,050	17,718
1932	49	917	716	168	4	1,854	13,287

[a] Data furnished by Jonas Waffle of the Indiana Coal Trade Association.
[b] Data by U. S. Bureau of Mines.
[c] Less than 500 tons.

The Lake cargo movement.—Appalachian coal moves into the mid-western and upper Lake states—principally Illinois, Wisconsin, Minnesota, and the Dakotas—in competition with coal from the producing fields of Illinois, Indiana, and western Kentucky. The apparent anomaly of a distant coal field entering a market already equipped with a local coal supply and coal-mining industry is the outcome of several factors, among which are:

1. Low water transportation rates.
2. Coal suitable for coking or other special purposes.
3. Difference in wage levels between eastern and western fields.
4. Summer work to supply the lake trade while the local demand is at a low ebb.

TABLE 10.—CONDENSED TABLE OF COAL SHIPMENTS TO STATES IN THE LAKE DOCK TERRITORY FROM ILLINOIS AND OVER THE LAKES, 1917 AND 1929, (EXCLUSIVE OF RAILWAY FUEL)[a]
(In net tons)

Distribution	1929		1917	
	Lake cargo	Illinois	Lake cargo	Illinois
Wisconsin	7,202,682	846,811	4,484,768	1,936,000
Minnesota	6,842,603	767,781	4,151,132	1,801,000
North Dakota	430,654	2,799	618,131	43,000
South Dakota	494,769	172,048	477,961	231,000
Chicago district	5,100,122	9,120,428	[b]	[b]
Illinois, other	267,791	14,027,684	1,050,221	25,780,675
Iowa	84,095	2,815,630	271,560	4,026,000
Kansas	.....	137,299	30	107,000
Nebraska	22,330	596,666	34,842	661,000

[a] Supplement to U. S. Bureau of Mines Coal Distribution Report No. 3, October 20, 1931, p. 14.
[b] Included in Illinois, other.

Table 10 gives a detailed statement of the distribution of coal moved over the Great Lakes in 1917 and 1929, including that used for railroad fuel, bunker coal, exports to Canada, and shipments to states not in the group included in the Illinois coal market area. This table discloses certain shifts in the market. The market outlet for lake cargo coal has decreased generally in the inland states but has shown substantial increases in those states bordering the lakes. Especially notable has been the growth in Illinois and Indiana where consumption has increased from 1,613,171 tons in 1917 to 5,367,913 tons in 1929. Of this quantity 5,100,122 tons of lake cargo coal was consumed in Chicago in the latter year.

In Table 9 is given comparative data on the shipments of coal from the Eastern Interior coal field and the lake cargo coal into the states bordering the lakes. Tonnages reported for the Eastern Interior coal field represent about 90 per cent of the coal moved from these states into the lake states.[3] This table shows the extent to which Illinois coal shares the lake states market with the associated coal fields of Indiana and western Kentucky as well as with the Appalachian fields.

[3] Data supplied by Mr. Jonas Waffle of the Coal Trade Association of Indiana.

The generally downward trend of coal shipments from Illinois and Indiana is offset by increases from western Kentucky. Nevertheless, the combined shipments from the three states comprising the Eastern Interior coal field is declining while shipments over the lakes are increasing.

Economic basis of the Lake cargo traffic.—The large market outlet for Appalachian coal in the lake states rests upon a lake-rail transportation combination which permits a lower delivery cost than the all-rail haul from the southern Illinois fields. Difference in the value of coal at the mines, differences in the quality of coal, and control of marketing agencies are contributing causes but the dominant factor is the freight rate structure. In delivering lake cargo coal to the states of Wisconsin, Minnesota, and the Dakotas, three major items enter into the cost of transportation. These are: the railroad rate from the coal fields to the lower lake ports; the lake haul; the railroad rate from upper lake ports to interior points. This complex transportation system affects three groups of competitors, namely, the northern Appalachian fields, mainly Pennsylvania, Ohio, and northern West Virginia; the southern Appalachian fields, mainly southern West Virginia and eastern Kentucky; and the Eastern Interior coal fields of which the Illinois fields are the leading ones.

The competitive position of the northern and southern Appalachian fields is affected by the first component of the transportation system, i. e., the rail rate from the fields to lower lake ports. The long and bitter struggle between these two groups of coal fields is not pertinent to the present discussion except to point out that the southern fields have gradually gained the ascendancy in supplying the lake cargo trade.

The factor of crucial interest is the position of Illinois in competition with lake cargo coal and this revolves around the element of delivered costs. Since lake rates are so exceedingly low per ton mile in comparison with rail-rates, the lake cargo coal has an undisputed advantage in the upper lake ports on Michigan and Superior—Chicago, Milwaukee, Kenosha, Sheboygan, Manitowoc, and Duluth-Superior. When, however, the lake cargo coal is re-shipped by rail to interior points in Minnesota and Wisconsin, freight rates add rapidly to the cost and a point is reached where the freight rates from Appalachian fields approach the all-rail rates from the fields of southern Illinois. The relation of transportation costs upon the competitive position of the lake cargo coal and the Illinois fields is shown in Table 11.

TABLE 11.—RAIL AND LAKE FREIGHT RATE FROM APPALACHIAN FIELDS

Field Origin	Rate to lower lake ports	Loading charge	Lake rate to Duluth	Total rate to Duluth	Lake rate to Milwaukee
Ohio					
Hocking and No. 8	$1.43	$0.08	$0.35	$1.86	$0.50
Pennsylvania and No. W. Virginia					
Pittsburgh	1.46	.08	.35	1.89	.50
Connellsville	1.54	.08	.35	1.97	.50
Meyersdale	1.73	.08	.35	2.16	.50
So. West Virginia					
Kenova	1.81	.08	.35	2.24	.50
Cumberland-Piedmont	1.83	.08	.35	2.26	.50
Kanawha	1.81	.08	.35	2.24	.50
Tug River-Pocahontas	1.96	.08	.35	2.39	.50
Eastern Kentucky					
Hazard	1.81	.08	.35	2.24	.50
Harlan-Benham	1.81	.08	.35	2.24	.50
Illinois (Herrin)					
Belleville					
Springfield					
Northern					

RAIL–LAKE–RAIL RATES

	Rail rates to Milwaukee	Madison, Wisconsin	Prairie du Chein
Rail rates from Milwaukee		$1.58	$2.10
Ohio			
Hocking and No. 8	2.01	3.59	4.11
Pennsylvania and No. W. Virginia			
Pittsburgh	2.04	3.62	4.14
Connellsville	2.12	3.70	4.22
Meyersdale	2.31	3.89	
So. West Virginia			
Kenova	2.39	3.97	4.49
Cumberland-Piedmont	2.41	3.99	4.51
Kanawha	2.39	3.97	4.49
Tug River-Pocahontas	2.39	3.97	4.49
Eastern Kentucky			
Hazard	2.39	3.97	4.49
Harlan-Benham	2.39	3.97	4.49
Illinois (Herrin)			
Saline Co.		2.75	3.07
Belleville		2.65	3.07
Northern			

[a] Authority: Interstate Commerce Commission.

AND RAIL RATES FROM ILLINOIS FIELDS TO INTERIOR POINTS [a]

Total rate to Milwaukee	Lake rate to Chicago	Total rate to Chicago	Rail-lake-rail rate via Duluth to			
			Minneapolis St. Paul 1.82[b]	St. Cloud +1.75[b]	Crookeston +2.61[b]	Fargo, N. D. +2.61[b]
$2.01	$0.50	$2.01	$3.68	$3.61	$4.47	$4.47
2.04	.60	2.04	3.71	3.64	4.50	4.50
2.12	.50	2.12	3.79	3.72	4.58	4.58
2.31	.50	2.31	3.98	3.91	4.77	4.77
2.39	.50	2.39	4.06	3.99	4.85	4.85
2.41	.50	2.41	4.08	4.01	4.87	4.87
2.39	.50	2.39	4.06	3.99	4.85	4.85
2.39	.50	2.39	4.21	4.14	5.00	5.00
2.39	.50	2.39	4.06	3.99	4.85	4.85
2.39	.50	2.39	4.06	3.99	4.85	4.85
.....	.....	.....	3.75	4.01	5.15	5.00
.....	.....	.....	3.65	.....	.....	.....
.....	.....	.....	3.45	.....	.....	.....

VIA MILWAUKEE TO

St. Paul Minneapolis	Fargo, N. D.	Rapid City, S. D.	Des Moines, Iowa	Sioux City, Iowa	Omaha, Nebraska	Kansas City, Missouri
2.61	4.20	5.83	2.86	3.59	3.52	3.52
4.62	6.21	7.84	4.87	5.60	5.53	5.53
4.65	6.24	7.87	4.90	5.63	5.56	5.56
4.73	6.32	7.95	4.98	5.71	5.64	5.64
4.92	6.51	8.14	5.17	5.90	5.83	5.83
5.00	6.59	5.22	5.25	5.98	5.91	5.91
5.02	6.61	8.24	5.27	6.00	5.93	5.93
5.00	6.59	8.22	5.25	5.98	5.91	5.91
5.00	6.59	8.22	5.25	5.98	5.91	5.91
5.00	6.59	8.22	5.25	5.98	5.91	5.91
5.00	6.59	8.22	5.25	5.98	5.91	5.91
3.75	5.00	.....	5.15	4.15	3.62	.....
3.75	.....	6.74	.....	.....	.....	.....
3.75	.....	6.64	5.05	4.05	3.32	2.98

[b] Rates from Duluth to interior points.

The dominance of lake cargo coal in the area served by Duluth is explainable when comparative freight rates are examined. Only in the Twin Cities is the Illinois freight rate comparable with some of the more remote districts of the Appalachian coal field. The coal of northern Illinois, although of lower quality than either the southern Illinois coal or that from the Appalachian fields reaches the Twin Cities in rather large quantities. One very large consumer of coal who uses it exclusively in power production consumes well over 100,000 tons annually. It is well adapted to use in plants where boilers are equipped with travelling grates.[4]

Lake dock vs. all-rail coal.—While lake dock coal dominates the market in the Duluth area and is important in the Milwaukee distribution zone, there is still a substantial amount of all-rail coal coming into the market both from Illinois and from eastern fields. Several important factors determine which the coal dealer will purchase. Although price is the dominant factor, quality also plays an important part. All-rail coal is generally superior in quality, whereas dock coal is cheaper. The ability of all-rail coal to enter this market in spite of higher transportation costs is accounted for, in part, by the factor of degradation of lake cargo coal. This varies with the type of coal handled.

In its course from mine to consumer, coal passes through many handlings, most of them rough ones. When screened at the tipple it leaves the mine properly sized. All-rail coal before it reaches its destination encounters numerous bumps and other rough treatment with the result that there is much breakage.

"Coal subjected to dock handling suffers much rougher treatment than any rail-shipped car, and there is a corresponding increase in degradation. Upon leaving the mines it is taken to Lake Erie ports, where the cars are lifted and turned upside down and their contents poured into the holds of vessels. This fall of from twenty to fifty feet results in tremendous breakage. Upon arrival at the Superior dock, the boat is unloaded by means of six- or eight-ton clams, which crunch into the cargo and bite out clamfuls of coal, smashing much of it in the process. This is conveyed over a bridge to the dumping ground, where the clams open and spill the contents in another fall of from twenty to forty feet. When prepared to load, the clams again dig the coal out of these piles and drop it into the screening device, which separates it into sizes.

"The process results in a degradation at the docks varying from 5-6 per cent on the best grades of anthracite coal, which is more carefully handled, to 60 or 70 per cent on the brittle Pocahontas. This coal, when delivered to the retailer dealer, must be screened again if it is sold to domestic trade. The docks use a 1¼-inch screen for most of their rescreening and the dealer usually uses about the same measure. Everything that goes through the screen is sold as screenings."[5]

The above rather detailed description of the effects of handling upon the size of coal has been introduced because of its relations to one market group—the domestic user. Screenings are sold to industrial consumers frequently at prices below the delivered cost at the Upper Lake Docks. To insure an overall profit

4 Vaile, R. S., and Pickett, V. G., Coal Distribution in the Twin Cities, The University of Minnesota Press, 1932, p. 20.

5 Vaile, R. S., and Pickett, V. G., Coal Distribution in the Twin Cities, University of Minnesota Press, 1932, pp. 38, 39.

to the coal dealer, the retail consumer is called upon to pay a price for his coal that helps to offset the low price at which screenings are sold to the steam trade.

Lake trade and the Chicago coal market.—The Chicago coal market is of particular interest because of the large quantities of coal consumed, the several sources from which coal is obtained, and the diversity of the market. Table 12 gives a detailed statement of the quantities of coal shipped to the Chicago district in 1929 and the sources of the coal.

TABLE 12.—COAL SHIPMENT TO CHICAGO SWITCHING DISTRICT IN 1929 FROM VARIOUS FIELDS[a]

Middle and Southern Appalachian High Volatile Districts	
Kenova-Thacker, Logan, Kanawha	1,755,503
Northwestern Kentucky and McRoberts	1,678,165
Hazard	259,355
Southeast Kentucky, Harlan-Benham	3,679,233
Virginia	57,287
Appalachian Low Volatile Districts	
Central Pennsylvania	11,516
Somerset-Meyersdale and Cumberland-Piedmont	23,494
New River-Winding Gulf	5,205,975
Pocahontas-Tug River	5,666,362
Northern Appalachian High Volatile Districts	
Western Pennsylvania and West Virginia Panhandle	310,018
Northern West Virginia	67,409
Northern Ohio	318
Southern Ohio	29,547
Lake Dock Bituminous Coal	5,100,122
Eastern Interior Coal Field	
Illinois	9,120,428
Indiana	3,464,627
Western Kentucky	925,018
Total	37,354,377
All-rail	32,254,255

[a] U. S. Bureau of Mines, Supplement to Monthly Coal Distribution Report, Nos. 1-4, 6.

The wide diversity of sources from which Chicago obtains its coal supplies is a consequence of the nature of the market, quality of the coal, differences in the freight rate structure, and differences in the cost of coal at the mines.

Coking coal market.—One of the important outlets for coal in the Chicago area is the by-product coke oven. This includes the ovens in Gary and Iniana Harbor as well as those in the Illinois portion of the Chicago area. This district includes approximately 85 per cent of the oven capacity of Illinois and Indiana. The source and quantity of coal used in the ovens of these states in 1929 to 1932 inclusive is shown in Table 13.

TABLE 13.—QUANTITY AND SOURCE OF COAL USED FOR COKING IN ILLINOIS AND INDIANA, 1929-1933 [a]

Source	State Used	
	Illinois	Indiana
1929		
Illinois	563,566	.....
Kentucky	1,847,183	2,515,896
Pennsylvania	[b]	658,921
Virginia	[b]	
West Virginia	3,046,180	5,574,111
Total	5,973,322	8,748,928
Total Illinois and Indiana		14,722,250
1930		
Illinois	565,362	.....
Kentucky	1,312,004	2,569,228
Pennsylvania	503,591	382,166
West Virginia	2,727,597	3,948,759
Total	5,108,554	6,900,153
Total Illinois and Idiana		12,008,711
1931		
Illinois	434,708	
Kentucky	997,326	1,542,452
Pennsylvania	355,510	
West Virginia	1,745,350	2,348,674
Total	3,532,894	3,891,126
Total Illinois and Indiana		7,424,020
1932		
Illinois	158,673	
Kentucky	536,006	701,366
Pennsylvania	304,323	
West Virginia	1,162,827	1,373,269
Total	2,161,829	2,074,635
Total Illinois and Indiana		4,236,464
1933		
Illinois	318	
Kentucky	434,362	1,223,551
Pennsylvania	276,946	33,029
West Virginia	1,551,375	1,688,594
Total	2,263,001	2,945,174
Total Illinois and Indiana		5,208,175

[a] Data from U. S. Bureau of Mines, Coke and By-Products in 1929, 1930, 1931, and 1932.
[b] Not separately reported.

TABLE 14.—FREIGHT RATES ON COAL SUPPLYING THE CHICAGO MARKET AND PRICE OF COAL AT THE MINES [a]

Field of Origin	Coal delivered by all-rail haul in 1929 in net tons	Freight rate all-rail haul	Rates on Lake Cargo Coal				
			Rail to lake	Loading charge	Lake rate	Total	Mine price
Middle and Southern Appalachian High Volatile Districts							
Kanawha, Logan, Kenova-Thacker	1,755,503	$3.09	$1.81	$0.08	$0.50	$2.39	$1.47
N. E. Kentucky and McRoberts	1,678,175	3.09	1.81	.08	.50	2.39	....
Hazard	259,355	3.09	1.81	.08	.50	2.39	1.57
Southeast Kentucky, Harlan-Benham	3,679,233	3.09	1.81	.08	.50	2.39	1.73
Virginia	57,287	....	1.96	.08	.50	2.54	1.64
Appalachian Low Volatile Districts							
Central Pennsylvania	11,516	2.90	1.73	.08	.50	2.31	1.79
Somerset-Meyersdale and Cumberland-Piedmont	23,494	3.29	1.73	.08	.50	2.31	1.77
New River-Winding Gulf	5,205,975	3.29	1.96	.08	.50	2.54	1.75
Pocahontas-Tug River	5,666,362	3.29	1.96	.08	.50	2.54	1.72
Northern Appalachian High Volatile Districts							
Western Pennsylvania and West Virginia Panhandle	310,018	2.90	1.46	.08	.50	2.04	1.42
Northern West Virginia	67,409	....	1.83	.08	.50	2.41	1.13
Northern Ohio	318	....	1.43	.08	.50	2.01	1.74
Southern Ohio	29,547	....	1.43	.08	.50	2.01	1.93
Illinois	9,120,428	1.95	....	....	....	....	1.95
Indiana	3,464,627	....	....	....	....	....	....
Western Kentucky	925,018	2.30	....	....	....	....	....

[a] Authority: Interstate Commerce Commission.

The importation of from 10 to 14 million tons of coal from Appalachian fields into the Chicago market arises out of the need for coals suitable for the coking process and is not to be regarded as a competitive relationship between eastern and interior coal fields. The small quantity of Illinois coal entering this market is used mainly for mixing with eastern coals.

Apart from the coking coal industry, the Chicago market consumes coal for steam purposes, domestic heating, railroads, and in the "heat" industries, e. g., glass and clay products manufacture, etc. In these industries and markets the need for a special type of coal is not so exacting as in the case of coking coal. Competition among coal fields, therefore, becomes more a matter of cost, and cost is contingent upon freight rates and mine price. The comparative freight rate costs on coal from the fields supplying the Chicago market is shown in Table 14.

Although freight rates to Chicago from the eastern fields are lower over the lakes than by all-rail haul, the latter is apparently the favored method of shipment to the Chicago district.

Effect of West Kentucky development upon the Illinois coal industry.—The rise of western Kentucky coal production in competition with the older fields of Illinois and Indiana parallels the development of the southern Appalachian fields in West Virginia and eastern Kentucky at the expense of Pennsylvania and Ohio. While the rate of increase in western Kentucky has not been as phenomenal as in the eastern fields of that state, most of the increase has been shipped to states comprising the Illinois coal market area. A comparison for 1917, 1918, and 1929, three years for which detailed distribution data are available, shows the marked increase in the use of western Kentucky coal in Illinois and neighboring states. (Table 15).

TABLE 15.—DISTRIBUTION OF WESTERN KENTUCKY COAL IN 1917, 1918, AND 1929 [a]
(In net tons)

	1917	1918	1929
Chicago district	[b]	[b]	925,018
Illinois, other	447,000	105,638	1,418,172
Indiana, other	720,000	262,484	382,911
Iowa	63,000	15,046	941,391
Kansas	15,000	3,145	81
Minnesota	.....	92	192,058
Missouri	214,000	62,598	635,985
Nebraska	36,000	.....	119,802
North Dakota	.....	.....	4,989
South Dakota	3,000	.....	45,864
Wisconsin	110,000	26,304	410,896
Total	1,608,000	479,307	5,077,167

[a] U. S. Bureau of Mines, Monthly Coal Distribution Report, Nov. 20, 1931, Supplement No. 4.
[b] Not available.

Rise in shipments to Illinois, Iowa, Minnesota, Missouri, Nebraska, and Wisconsin has been particularly significant.

Competition of Western Interior and Rocky Mountain coal fields.—Illinois shares the market west of Mississippi River with the local coal fields of Iowa, Missouri, and Kansas, with coal imported from Arkansas and the Rocky Mountains, and with minor shipments from the Appalachian fields. The origin of coal consumed in the states comprising the Illinois coal market area is shown in Table 16.

In the coal producing states west of the Mississippi River particular attention should be called to the wide distribution of Arkansas coal. This product is of anthracite rank and is widely used as a domestic fuel. Competition with Illinois coal is most severely felt in Missouri. The coal fields of Iowa mainly serve a local market since more than 90 per cent of the total production (exclusive of railroad fuel) is consumed within the state. The local character of the coal industry in Kansas and Missouri is also evident from the restricted nature of the market. Eighty-three per cent of the output (exclusive of railway fuel) is used in Missouri and Kansas and more than 99 per cent in these states and Nebraska.

The competitive influence of Rocky Mountain coals is confined mainly to the western portions of this coal consuming area. Colorado coal is significant only in Kansas and Nebraska, Montana coal is confined practically to the North Dakota market, and Wyoming coal is important only in Nebraska and the Dakotas. Oklahoma, although considered outside of the Illinois coal market area, finds a considerable outlet in its neighboring states of Missouri and Kansas.

TABLE 16—COAL SHIPPED TO CONSUMERS IN SIX STATES WEST OF MISSISSIPPI RIVER IN 1929. (EXCLUSIVE OF RAILWAY FUEL)[a]

(In Net Tons)

Producing State and District	Consuming States: Iowa	Missouri	Kansas	Nebraska	Minnesota	Dakotas	Total
Illinois	2,815,630	5,884,713	137,299	596,666	767,781	174,847	10,376,936
Indiana	483,502	86,046	3,057	26,735	39,307	5,635	644,282
Western Kentucky	941,391	635,985	81	119,802	192,058	50,853	1,940,170
Appalachian fields (all-rail)	1,793,051	440,467	9,755	14,955	463,533	95,748	2,817,509
Lake Shipments	84,095	.....	.....	22,330	6,842,603	925,423	7,870,451
States west of the Mississippi River							
Arkansas	76,534	333,880	190,028	269,163	96,881	10,503	976,989
Colorado	15,670	1,108	525,908	866,495	677	50,050	1,459,908
Iowa	1,704,315	190,478	3,639	4,235	2,920	.....	1,905,587
Kansas and Missouri	26,182	2,358,065	1,054,426	842,757	654	.....	4,282,084
Montana	2,756	.....	.....	313	8,078	150,010	161,157
North Dakota	29	.....	.....	6,223	37,546	1,373,565	1,417,363
Oklahoma	47,701	244,271	350,060	211,307	32,133	4,215	889,687
Utah	84	82,986	24,001	35,524	.....	.....	142,595
Wyoming	20,362	2,752	21,412	588,788	2,568	209,740	845,622
New Mexico	.....	594	48,319	6,223	.....	.....	55,136
Total	1,893,633	3,214,134	2,217,793	2,831,028	181,457	1,798,083	12,136,128

Coal produced in	Iowa	Missouri and Kansas	North Dakota
Used as:			
Colliery fuel	57,239	152,992	38,502
Sold to local trade	800,029	750,024	380,640
Railroad fuel			
For originating railroads	1,547,750	1,763,570	14,953
For other railroads	19,696	90,924	1,481

[a] Supplements 1, 2, 3, 4, and 6 of Monthly Coal Distribution Report, U. S. Bureau of Mines, August, September, October, November, 1931, and January, 1932.

CHAPTER III

FUEL OIL IN THE ILLINOIS COAL MARKET AREA

IMPORTANCE AS A SOURCE OF HEAT AND POWER

The importance of fuel oil as a source of heat and power and a competitor of coal in the energy market is evident, not only from the large and diverse market for this fuel but also the consistent growth in consumption during the period for which records are available. The principal areas of fuel oil consumption in the United States have been in districts devoid of coal supplies such as the West Coast states, the North Atlantic Coast regions (including fuel oil used for bunkering), the Mid-Continent and Gulf Coast region, and the Chicago area. By comparison, fuel oil consumption in the Illinois coal market area has been a less important factor than the industrial eastern seaboard, or the crude oil producing regions in the Mid-Continent, the Gulf Coast, and California. The position of this energy market area as a consumer of fuel oil compared with the United States as a whole is as follows:[1]

	Consumption in 1934	
	Fuel oil (barrels)	Coal equivalent
United States	330,321,000	78,648,000
Illinois coal market area	33,302,000	7,929,000
Exclusive of Kansas and Nebraska	25,457,000	6,061,000

1 A. T. Coumbe, Jr., National distribution of fuel oil, 1931: U. S. Bureau of Mines, Mineral Market Report No. 415, Nov. 19, 1935.

Total consumption of fuel oil in the states comprising the Illinois coal market area and consumption by principal types of customers is given in Tables 17 and 18 below and figures 1 and 2. Total consumption in the area, as given in Table 17, is distributed among nineteen different consumer groups as listed in the annual reports on fuel oil distribution prepared by the U. S. Bureau of Mines.[2] In Table 18, consumption by six of the leading consumers groups which account for about 80 per cent of the total consumption is reported. Consumption of the re-

2 See "National Survey of Fuel Oil Distribution" for the years 1927 to 1931 by E. B. Swanson and others of the U. S. Bureau of Mines. The groups of consumers listed in these reports are railroads, steamships (including tankers), gas and electric power plants, smelters and mines, iron and steel products, chemicals and allied industries, automotive industries, textiles and their products, paper and wood pulp, logging and lumbering, cement and lime plants, ceramic industries, food industries, other manufacturing, commercial heating, domestic heating, U. S. Navy, Army transports, etc., fuel used by oil companies, miscellaneous uses.

TABLE 17.—FUEL OIL CONSUMPTION IN THE
(In barrels of

Year	Illinois	Wisconsin	Minnesota	Iowa
1926	8,992,051	1,101,141	979,585	666,153
1927	11,445,021	1,411,161	1,404,070	659,790
1928	14,127,611	1,474,385	1,478,911	786,897
1929	13,257,751	1,640,396	1,548,860	881,970
1930	12,627,298	1,567,486	1,573,627	1,105,538
1931	11,133,114	1,393,406	1,764,881	960,481
1934	13,206,000	2,415,000	2,796,000	1,032,000
Fuel oil Consumption by Railroads in the				
1926	188,305	81,101	10,927	13,349
1927	233,502	44,937	32,924	19,985
1928	370,898	26,279	64,800	30,836
1929	499,808	76,544	87,465	30,546
1930	496,121	18,193	21,296	28,173
1931	278,181	10,053	29,114	45,960
1934	396,000	55,000	34,000	47,000
Fuel oil used for commercial heating in the				
1926	779,073	98,558	198,251	24,852
1927	1,105,040	203,182	463,385	20,720
1928	1,398,296	275,595	321,390	69,032
1929	1,336,604	289,044	285,360	93,554
1930	1,230,549	301,972	381,665	76,569
1931	1,117,696	204,049	474,971	65,028
1934[b]	.....	.....	.....	.....
Fuel oil for domestic heating in the				
1926	650,075	76,694	12,930	20,874
1927	1,151,069	159,192	299,583	79,382
1928	1,567,725	187,986	227,267	66,167
1929	1,792,649	416,784	290,640	93,554
1930	1,870,439	499,045	388,950	244,783
1931	1,716,692	428,020	497,983	239,532
1934[b]	.....	.....	.....	.....
Fuel oil used in the iron and steel industry in the				
1926	.....	.....	.....	.....
1927	2,409,123	392,649	72,158	58,753
1928	3,339,161	302,078	44,012	65,423
1929	2,356,655	216,281	104,648	63,925
1930	2,006,043	211,988	40,845	25,381
1931	2,103,861	221,759	30,567	15,398

[a] National Survey of Fuel Oil Distribution, U. S. Bureau of Mines, report for year 1927, 1928, 1930, and 1931.

[b] For the year 1934, data on consumption of heating oil is not separately available for commercial and domestic use. The figures for the combined uses are as follows: Illinois, 7,348,000 barrels; Wisconsin, 1,776,000 barrels; Minnesota, 2,002,000 barrels; Iowa, 651,000 barrels; Missouri, 2,777,000 barrels; North Dakota, 170,000 barrels; South Dakota, 162,000 barrels; Nebraska, 556,000 barrels; Kansas, 171,000 barrels; total—15,633,000 barrels in 1934 as compared with a total consumption of 6,552,000 barrels in 1931.

ILLINOIS COAL MARKET AREA, 1926-1934 [a]
42 gallons each)

Missouri	North Dakota	South Dakota	Nebraska	Kansas	Total without Kansas and Nebraska	Total
3,146,747	40,182	121,909	748,547	5,164,216	17,047,768	22,960,531
5,296,509	25,070	106,046	670,586	4,815,814	20,347,667	25,834,067
4,516,311	63,202	130,322	637,193	5,653,993	22,577,639	28,868,825
4,750,722	109,655	154,290	810,027	5,717,494	22,343,644	28,871,165
4,468,199	128,201	154,886	849,099	4,660,793	21,625,235	27,135,127
4,222,271	105,077	205,450	801,890	5,437,761	19,784,680	26,024,331
5,456,000	199,000	353,000	1,152,000	6,693,000	25,457,000	33,302,000
Illinois coal market area, 1926-1934						
1,640,082	.....	7,680	19,998	1,873,739	.....	.....
1,606,206	382	9,979	27,233	1,918,966	.....	.....
1,196,814	10,582	2,284	43,947	1,808,457	.....	.....
1,581,030	10,608	10,227	108,105	1,818,223	.....	.....
1,146,110	603	18,435	48,734	1,414,155	.....	.....
1,187,022	543	37,317	76,168	1,604,392	.....	.....
1,362,000	2,000	73,000	176,000	3,392,000	.....	.....
Illinois coal market area, 1926-1934						
642,915	16,518	11,136	23,332	242,651	.....	.....
660,066	18,244	18,665	56,000	116,159	.....	.....
755,129	19,982	22,211	39,850	227,794	.....	.....
715,928	26,478	30,580	49,032	161,418	.....	.....
873,185	41,114	36,675	103,903	80,406	.....	.....
764,497	47,599	46,958	110,716	53,932	.....	.....
.....	.....	.....	.....	.....	.....	.....
Illinois coal market area, 1926-1934						
294,399	.....	452	116,601	24,482	.....	.....
340,425	.....	4,575	150,516	23,962	.....	.....
257,987	3,424	4,303	109,616	19,214	.....	.....
297,834	39,819	4,152	115,014	37,101	.....	.....
542,014	42,514	5,514	228,517	29,137	.....	.....
553,996	31,684	23,368	141,148	29,788	.....	.....
.....	.....	.....	.....	.....	.....	.....
Illinois coal market area, 1926-1931						
.....	.....	.....	.....	.....	.....	.....
358,966	.....	.....	192	11,211	.....	.....
519,277	1,757	1,757	2,163	3,336	.....	.....
291,035	7,000	7,000	1,962	15,970	.....	.....
115,639	.....	.....	3,340	1,565	.....	.....
125,239	.....	.....	1,000	3,933	.....	.....

TABLE 18.—FUEL OIL CONSUMPTION BY PRINCIPAL USES IN THE ILLINOIS COAL MARKET AREA, 1926-1931 [a]

(In barrels of 42 gallons each)

Year	Commercial heating	Domestic heating	Railroads	Iron and steel products	Fuel used by oil companies	Gas and electric power plants	Total of these items	Grand total consumption	Percentage	4.2:1 coal equivalent
1926	1,336,186	1,196,507	3,835,181	(b)	3,774,100	3,550,527	13,692,501	22,960,531	.....	.....
1927	2,661,461	2,168,704	3,894,114	3,303,052	5,341,828	3,799,112	21,168,271	25,834,067	82	6,150,000
1928	3,179,189	2,493,689	3,554,897	4,279,764	5,480,780	4,534,742	23,523,061	28,868,825	82	6,880,000
1929	2,953,971	3,087,547	4,222,556	3,064,476	6,209,323	4,132,725	23,670,598	28,871,165	82	6,880,000
1930	3,127,043	3,850,913	3,191,820	2,404,801	5,372,237	3,954,194	21,901,008	27,135,127	81	6,460,000
1931	2,885,206	3,666,711	3,268,750	2,501,757	5,154,916	3,851,372	21,323,712	26,024,331	82	6,200,000
Exclusive of Kansas and Nebraska										
1926	1,070,203	1,055,424	1,941,444	(b)	2,162,591	2,616,027	8,845,689	17,047,768	.....	.....
1927	2,489,302	2,034,226	1,947,915	3,291,649	3,614,181	3,000,793	16,378,066	20,347,667	80	4,840,000
1928	2,861,545	2,364,859	1,808,457	4,274,265	3,295,920	3,675,184	18,276,230	22,577,639	81	5,365,000
1929	2,743,521	2,935,432	2,296,228	3,046,544	3,625,142	3,283,218	17,930,085	23,343,644	77	5,550,000
1930	2,942,729	3,593,259	1,728,931	2,399,896	2,986,708	3,257,213	16,908,736	21,625,235	78	5,150,000
1931	2,720,558	3,490,775	1,588,190	2,496,824	2,347,744	3,203,945	15,848,036	19,784,680	80	4,700,000

[a] National Survey of Fuel Oil Distribution, U. S. Bureau of Mines, Annual report for 1927, 1928, 1929, 1930, and 1931.
[b] No data.

maining 20 per cent is among 13 groups of consumers each of which is so small as to have little effect upon the trend of fuel oil consumption. Of the six consumer groups which are separately reported in Table 18, the outstanding characteristic is the rapid increase in the use of fuel oil for commercial and domestic heating. In the remaining four groups consumption is either stationary or tending to decline. The factors responsible for the trends in each of these groups is a resultant of comparative price levels with coal, the factor of convenience, and the adaptability of a fuel in liquid form for certain specific purposes. Each of these will be analyzed in more detail in the discussion of the fuel consumption by industrial groups. The coal equivalent of fuel oil in the Illinois coal market area (exclusive of Kansas and Nebraska) is slightly in excess of 5,000,000 tons.

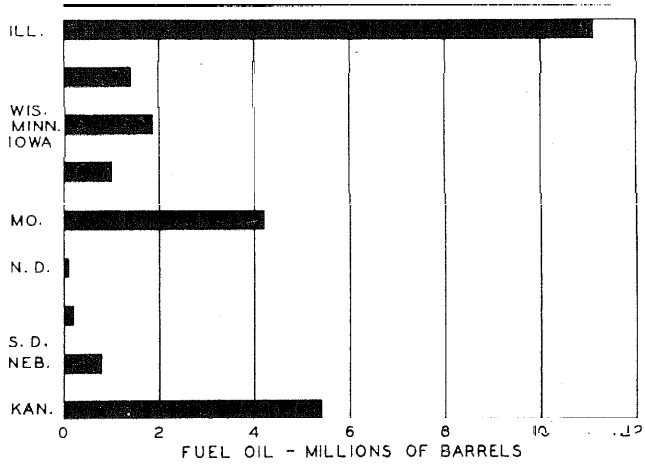


Fig. 1.—Consumption of Fuel Oil by States in the Illinois Coal Market Area.

COMPETITIVE POSITION OF FUEL OIL IN THE ENERGY MARKET

Conditions governing supply of fuel oil.—In order to evaluate the competitive position of fuel oil in the energy market, it is necessary that the economic nature of this product be clearly understood. Fuel oil is a by-product of the gasoline manufacturing industry. As a fuel it serves no peculiar need (with minor exceptions) that cannot also be supplied by coal. The large supply of fuel oil available in the United States is due to two factors: First, the nature of oil and the methods of refining were such as to yield a larger percentage of the by-product fuel oil than the cash crop of the refining industry—gasoline. Until 1925, 50 per cent or more of the products of crude oil was in the form of fuel oil; secondly, the mounting demand for gasoline occasioned by the rapid expansion of automobile output was accompanied by the production of correspondingly large quantities of fuel oil. In 1931 the domestic deliveries of fuel oil mounted to

313,092,780 barrels,[3] an equivalent of 74,545,900 tons of coal. Although the wider use of cracking methods is effecting a higher percentage of gasoline recovery, this has not brought about an appreciable decline in the available fuel oil supply. The key to the quantity of fuel oil supply is the rate of crude oil production. As long as crude is being produced in abundant quantities the refining end of the oil industry finds it more expedient to recover from the crude only the

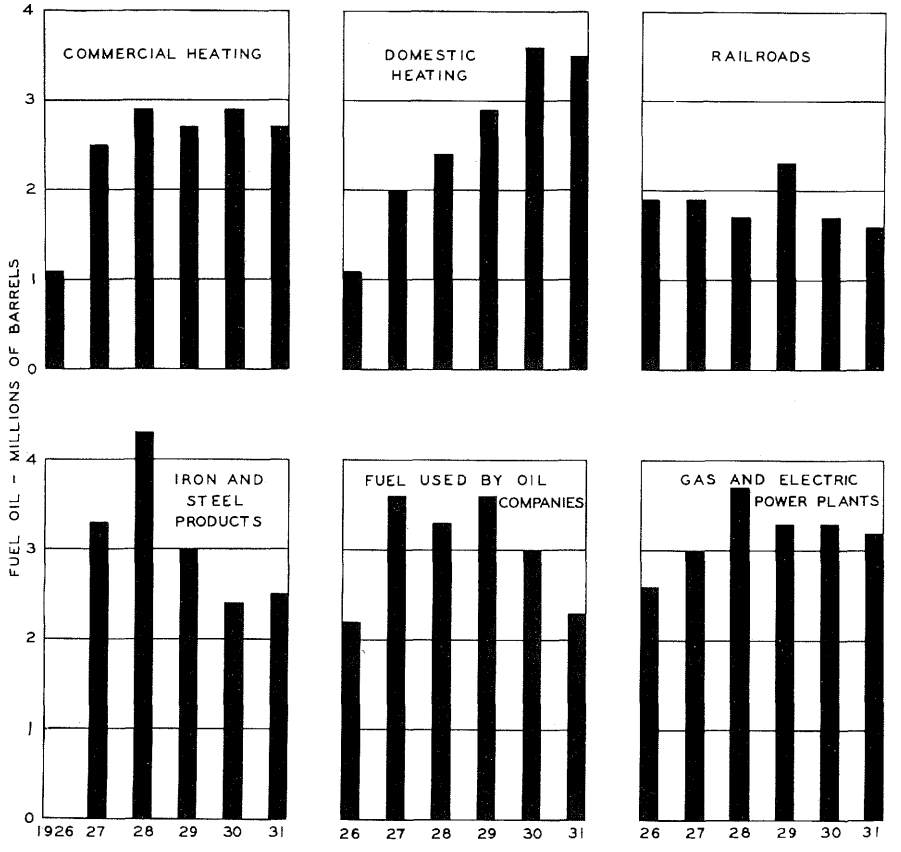


Fig. 2.—CONSUMPTION OF FUEL OIL BY PRINCIPAL USES IN THE STATES COMPRISING THE ILLINOIS COAL MARKET AREA.

percentage of gasoline that can be obtained by skimming and cracking methods and throw the residue on the market as fuel oil at whatever price it will bring. A decline in fuel oil supply can be brought about only by controlling crude output to such a degree that rising prices of both crude and gasoline will reach a point where it is more profitable to increase the percentage of gasoline output by cracking and hydrogenation than it is to sell it as fuel oil. The oil industry is just

[3] U. S. Bureau of Mines, Fuel Oil Distribution in 1931.

emerging from a period of excessive production occasioned by discoveries of prolific producing fields and, unless further upsets occur, will be in a fair position to bring crude production more nearly in line with demand. This objective, if achieved, will result in a higher price for crude and gasoline, and eventually affect the price of fuel oil.

Conditions governing the distribution of fuel oil.—Since fuel oil is difficult to transport by pipe line and costly to carry by tank car, the key factor in determining the major areas of consumption is refinery location. In the Illinois coal market areas four well defined refinery centers may be discerned. These are

(1) The Chicago district.
(2) East St. Louis district.
(3) Eastern Illinois district.
(4) Kansas City.

Refinery capacities in each of the districts is given in Table 19 below:

TABLE 19.—APPROXIMATE DAILY CRUDE REFINING CAPACITY IN THE ILLINOIS COAL MARKET AREA

	Daily Crude Capacity Barrels of 42 gallons each
Chicago District	200,000
East St. Louis District	86,000
Eastern Illinois	26,000
Sugar Creek (Kansas City)	20,000
Total	332,000

The distance over which fuel oil can be transported from the refinery center to the consuming market is determind largly by the rate at which the freight charges bring the cost of fuel oil up to a competitive level with that of coal. Secondary factors which may enlarge somewhat the radius over which fuel oil is moved is a demand occasioned by special uses or convenience. The concentration of fuel oil utilization near the refinery centers is illustrated by data for consumption of fuel oil in manufacturing by counties as revealed by the Census for 1929. In that year the total consumption of fuel oil in the Illinois coal market area was as follows:

Entire Area ..... 28,871,165 barrels
Exclusive of Nebraska and Kansas ..... 22,343,644 barrels

Of this amount, the Census on "Consumption of Fuel and Electric Energy in Manufacturing Industries" allots to manufacturing the following amounts:

Entire area ..... 20,353,200 barrels (70%)
Exclusive of Nebraska and Kansas ..... 16,758,188 barrels (75%)

The degree to which this consumption is concentrated near the source of production is revealed in the map of consumption of fuel oil for manufacturing purposes by counties. Of the total fuel oil used for manufacturing in this area, the distribution is given in Table 20.

TABLE 20.—DISTRIBUTION OF FUEL OIL USED IN MANUFACTURING

Refining center	Near refining centers Consuming counties in	Barrels (42 gallons each)
Chicago	Wisconsin	1,572,530
	Illinois	5,611,815
	Indiana	6,083,004
Total		13,267,349
East St. Louis	Illinois	3,536,634
	Missouri	930,000
Total		4,466,634
Eastern Illinois	Crawford Co. } Lawrence Co. }	685,650
Kansas City, St. Joseph	Missouri	1,091,572
Total		19,511,205

Next in importance to the refinery centers as consumers of fuel oil are the urbanized areas within these states. Consumption in the principal localities is as follows:

TABLE 21.—CONSUMPTION OF FUEL OIL IN URBAN AREAS

Area or city	State	Barrels (42 gallons each)
Tri-city district	Illinois	274,423
	Iowa	159,552
	Total	433,975
Peoria	Illinois	519,190
Danville-Champaign	Illinois	76,822
Joplin district	Missouri	23,262
St. Paul-Minneapolis area	Minnesota	596,482
Adrian Co.	Missouri	95,108
Henry Co.		88,988
Duluth, St. Louis Co.	Minnesota	58,925
Crown Wing Co	Minnesota	26,428
Total		2,023,787

Fuel oil consumed for manufacturing in the remaining counties of these states, after deducting the quantities used near the refining centers and the somewhat smaller quantities consumed in urban centers not located near refineries, amounts to 1,306,200 barrels (in the area exclusive of Kansas and Nebraska) or 7.8 per cent of the total used in manufacturing. While this distribution accounts for only that part of fuel oil consumption used in manufacturing, and does

not include fuel oil used for domestic and commercial heating and for railroads, nevertheless it represents 75 per cent of the total consumption and is a fair indicator of the geographical distribution of this type of fuel.

The above analysis implies that fuel oil is consumed near the source of production but takes no account of the balance between production and consumption within major refining zones. The situation in the Illinois coal market area is presented in Table 22 which gives production and consumption of fuel in the states comprising the Illinois coal market proper, and the same data for those states southeast of the Illinois coal market area in the Mid-Continent field whose principl refining area centers around Tulsa, Oklahoma. Indiana is included with the first group because of its large refining capacity near Chicago and a consequent outlet of its fuel oil into the Chicago area. The excess of production over consumption necessitates importation from the Mid-Continent field where the opposite condition exists. The transportation of fuel oil over this long distance was no doubt made economically feasible by the low prices prevailing in 1929, (Table 22) aided to some extent by cheap barge transportation over part of the distance.

TABLE 22.—CONSUMPTION AND PRODUCTION OF FUEL OIL, 1929 [a]
(In barrels of 42 gallons each)

	Production	Consumption	Excess or deficiency
Illinois	7,618,148	13,257,751	
Indiana[b]	11,327,427	5,581,087	
Wisconsin	.....	1,640,396	
Minnesota	.....	1,548,860	
North Dakota	.....	109,655	
South Dakota	.....	154,290	
Iowa	([c])	881,970	
Missouri	([c])	4,750,722	
Nebraska	.....	810,027	
	18,945,575	28,734,758	−9,789,183
Arkansas	5,764,696	2,633,170	
Kansas	8,177,175	5,717,494	
Oklahoma	21,455,321	11,971,557	
	35,397,192	20,322,221	+15,076,971

[a] Data from U. S. Census on Petroleum Refining, 1929, and Fuel Oil Distribution in 1930, U. S. Bureau of Mines.
[b] Includes Michigan, Iowa, and Missouri.
[c] Included with Indiana.

Table 22 brings out clearly the fact that competition in the energy market from fuel oil is of more than local significance. The economic nature of this fuel as a by-product of the gasoline manufacturing industry and a fuel market of such a nature that an exclusive outlet does not exist compel the refiners to sell it at prices determined by the price of coal. An excess of the fuel over normal needs, both in Chicago and the Mid-Continent has the effect of further depress-

ing prices below the level of an equivalent quantity of coal with the consequence that long distance shipments become feasible. An uncontrolled output of crude oil, encouraging a surplus of gasoline manufacture, further adds to supply of fuel oil and makes the competitive battle more keen. This situation was sharply in evidence in 1931 when fuel oil prices at the Olkahoma refineries fell to 27½ cents per barrel. Until the key to the situation is removed, i. e., until the output of crude is controlled and the price is raised to a point where increased cracking and recovery of gasoline becomes profitable, the fuel oil factor will be of critical competitive importance in the energy market.

CONDITIONS GOVERNING THE FUTURE TREND OF FUEL OIL CONSUMPTION IN THE ILLINOIS COAL MARKET AREA

The extent to which fuel oil will continue to compete in the fuel market of the Upper Mississippi Valley states is dependent upon two variables:

(1) The rate at which crude oil is produced and run to stills.

(2) The rate at which gasoline is consumed.

The relationship between these two variables is the dominant factor in determining the price of crude oil, of gasoline and of the by-product fuel oil.

When crude is produced in abundant quantities there is a tendency for the refiners to increase runs to still and increase stocks of gasoline. An ensuing drop in gasoline prices forces the adoption of refining methods which result in the gasoline recovery of only that part of the crude which can be obtained by low-cost methods, e. g., skimming or topping. The improved practices which make possible a higher gasoline recovery by re-running and cracking are not utilized because they add to the cost and cannot be used by one refinery when others, by using large supplies of crude and straight-run methods of refining, are underbidding in the gasoline market. The entire procedure is accompanied by a large output of by-product fuel oil which in turn is thrown upon the market for whatever price it will bring. The significance of the procedure was concealed somewhat as long as the annual demand for gasoline was showing substantial increases, but with the turn of economic events in 1930, when increasing demand disappeared and the years immediately following showed slight decreases, the consequences of this uneconomic procedure became acute. Heroic measures on the part of the leaders among the oil producers, accompanied by ruthless and drastic measures on the part of state authorities in 1931, served to stem the flood of crude oil to the extent that production and consumption were more nearly balanced. Curtailed consumption of fuel, including fuel oil, in the business recession of 1930-31-32, however, more than offset the decline in crude oil production so that the situation still remains acute. Although fuel oil consumption actually declined in 1930-32 from the 1929 level, this decline was not as pronounced as that occuring in coal. Meanwhile the low prices quoted for fuel oil, 30 cents a barrel in the Tulsa area, in June 1932, indicates an abundant supply available to fuel users. The situation in regard to the surplus fuel oil available in the Tulsa refining area

is intensified by the rapid expansion of the natural gas industry of the Mid-Continent area and the ensuing displacement of fuel oil in many of the local industries.

The remedy for this unsatisfactory and uneconomic condition, to the producers of petroleum themselves, as well as to the competing coal interests, lies in a substantial reduction of crude oil output. This has been emphasized again and again by Federal and State authorities, by the leaders in the oil industry, and by the producers of coal. The economic basis of controlled production is tersely stated by President Coolidge in his letter of December 19, 1924, creating the Federal Oil Conservation Board. He says in part:

"Overproduction in itself encourages cheapness, which in turn leads to wastefulness and disregard of essential values. Oil, of which our resources are limited, is largely taking the place of coal, the supply of which seems to be unlimited, but coal cannot take the place of oil in most of its higher uses, on land or sea or in the air."[1]

In its first report the Federal Oil Conservation Board amplified the position of the President in a statement as follows:

"The most essential products from our crude oil are lubricating oil, gasoline and other oils for internal combustion engines. The other uses for oil could be dispensed with, without an industrial revolution, as other fuels and substitutes could be applied without prohibition differentials in economic costs. At the present time, about one half of our crude oil production is burned either as crude oil or as fuel oil to generate steam and heat—the remainder is used as kerosene, gasoline, lubricating oil, etc.

"Up until thirteen years ago, the amount of gasoline which could be produced was limited to the natural fraction of gasoline in the crude product, but the discovery of cracking processes, by which the heavier oils can be broken down into gasoline, has opened an entirely new vision as to the gasoline supply."[2]

Aside from its importance as a conservation measure, curtailment of crude oil production would reestablish the petroleum industry on a sound economic footing by converting the major portion of it into the higher-valued gasoline and reducing operating costs incidental to the production and handling of large quantities of crude, much of which now is disposed of in the form of low-value fuel oil.

CONSEQUENCES OF DECLINE IN FUEL OIL SUPPLY

With the present indications of ample crude oil supply and the possibilities of greater economy in gasoline consumption, no sudden decline of fuel oil is to be expected. A gradual decline in supply would cause a corresponding rise in price to a point representing the actual value of fuel oil in its most advantageous uses in competition with coal. A considerable volume of present consumption in uses for which the advantage of fuel oil are not so great would readily and quickly revert to coal. The factors that determine the persistency of fuel oil consumption are: the special advantages of fuel oil for certain uses; the possibility of greater economy and efficiency in the use of fuel oil; the fact that the consumer in some cases is also a producer of some form of energy; the availability and the relative

1 Report of the Federal Oil Conservation Board to the President of the United States, September, 1926, Part I, p. 1.
2 Op. cit., p. 10.

cost of substitute fuels; the degree to which the use has become established; and the cost of changing the equipment.

The most notable example of special advantage of fuel oil is in *marine use,* and here it combines with the increasing fuel efficiency attained by the Diesel engine. The convenience of oil fuel for *domestic and commercial heating* is largely responsible for the rapid increase in use for this purpose. In both of these uses the factor of relative cost of fuel is of less significance.

In *railroad consumption* the cost factor is more important. Railroads in the Illinois coal market area have been substantial consumers of fuel oil and have absorbed much of the local surplus of fuel oil at prices generally below the level of coal competition. Under a condition of scarcity and rising prices for fuel oil, a rapid decline in consumption and a reversion to coal could be expected. Consumption should decline most rapidly in the central states, where railroad consumption has had its most rapid expansion, with consequent benefit to the railroads.

In the case of the *oil industry itself,* the fact that fuel oil is available at the lowest price for the use of the company that produces it, without any selling or transportation costs, while the opposite is true if other fuel is purchased, is an important consideration.The use of coal as a refinery fuel is restricted to areas of low cost coal or to operations where a high grade of crude oil is used with a small output of fuel oil. In case of a serious shortage of fuel oil much of this consumption might be replaced by coal, where natural gas is not available, but only after most of the other industrial users had made the change and where the fuel oil was needed for a higher priced marine market.

The consumption of fuel oil by *public utilities* has declined with the wider utilization of natural gas and the increased use of powdered coal. A material decline of fuel oil consumption in this group may be expected in case of fuel oil shortage.

The use of fuel oil in manufacturing represents a large and varied group of consumers, much of which is the result of an effort to extend the market for fuel oil at low prices in competition with coal and would decline greatly in the event of a shortage in fuel oil supply. The bulk of the oil is used for industrial heating or power purposes for which coal could be substituted.

CHAPTER IV

NATURAL GAS FACTOR IN THE ILLINOIS COAL MARKET AREA

Although natural gas has been produced and consumed in Illinois since 1886[1] and has been an important source of fuel for several years in the states of Missouri and Kansas on the southern border of the Illinois coal market area, it is only since 1930 that its consumption within this area itself has risen to a point where it must be recognized as a serious competitor in the energy market. From a consumption of 7,108,400,000 cubic feet for all purposes, in 1921, it rose to 108,202,000,000 cubic feet in 1934. This latter figure represents approximately an equivalent of 4 million tons of coal.[2]

The rapid increase of consumption in the Illinois coal market area is of particular interest because of its direct competition with coal produced in the Interior coal basin. Tables 23 and 24 show that the domestic use practically doubled but that a still more rapid increase occurred in industrial consumption. Particular attention should be given to the amount included under "other industrial consumption." This includes fuel used in manufacturing, public utilities, petroleum refining and cement plants. In each of these groups of industries coal and fuel oil are also used as fuels and the introduction of gas is a direct competitor of these in the energy market.

CONSUMPTION OF GAS IN FIELD OPERATIONS

Consumption of gas in field operations (drilling, pumping, and operating gasoline recovery plants) has been confined principally to Illinois and Kansas oil producing fields. Consumption for this purpose has been relatively small and is showing a decline in both states since 1925. Curtailment of oil production combined with increasing efficiency in the utilization of gas in field power equipment is responsible for this decline. The use of natural gas in oil field operations may be considered as non-competitive with coal. In reality, it represents a new fuel outlet occasioned by the development of a new industry and does not disturb existing markets for coal. The outlet for natural gas in oil field operations is limited, however, and will most likely become stabilized or even decline with the stabilization of oil production. The rapid increase in the use of gas for industrial purposes in 1930 and 1931 becomes of significance, therefore, since it represents a direct competition with coal and fuel oil.

1 Bell, A. H., Natural Gas in the Eastern Interior Coal Basin; Geology of Natural Gas: a Symposium, Amer. Assoc. Pet. Geologists, 1935, pp. 813-842.

2 One ton of coal is considered the equivalent of 25,000 cubic feet of natural gas.

TABLE 23.—TOTAL CONSUMPTION OF NATURAL GAS IN THE ILLINOIS COAL MARKET AREA BY STATES[a]
(In millions of cubic feet)

Year	Illinois	Wisconsin	Minnesota	Iowa	Missouri	North Dakota	South Dakota	Nebraska	Kansas	Total without Kansas	Total
1921	2,630	0	0	(b)	4,467	1	10	0	26,132	7,108	33,240
1922	3,383	0	0	(b)	4,874	1	16	0	28,348	8,274	36,622
1923	4,049	0	0	(b)	6,301	(b)	33	0	37,637	10,383	48,020
1924	4,072	0	0	(b)	5,394	(b)	3	0	40,528	9,469	49,997
1925	4,165	0	0	(b)	5,372	(b)	4	0	48,684	9,541	58,225
1926	3,808	0	0	(b)	5,819	(b)	10	0	61,142	9,637	70,779
1927	3,741	0	0	(b)	6,584	2	92	0	66,618	10,419	77,037
1928	3,051	0	0	(b)	6,957	(b)	214	0	72,671	10,222	82,893
1929	3,139	0	0	(b)	15,078	(b)	1,717	0	75,476	19,934	95,410
1930	9,602	0	0	(b)	26,122	(b)	3,979	1,098	68,598	40,801	109,399
1931	14,050	0	0	3,522	24,261	(b)	2,803	4,817	65,609	49,453	115,062
1932	29,432	0	0	7,533	25,310	(b)	2,776	8,661	56,965	73,712	130,677
1933	33,341	0	0	11,408	27,584	0	3,264	10,293	57,032	85,890	142,922
1934	45,084	0	0	16,636	29,792	0	3,901	12,789	65,599	95,413	173,801

[a] Mineral Resources of the United States, Annual chapters on natural gas.
[b] Included in other states.

DISTRIBUTION OF NATURAL GAS IN THE ILLINOIS COAL MARKET AREA

In addition to local production in Illinois, natural gas enters the state through long distance pipe lines originating in the Monroe field, Louisiana, the Panhandle field of Texas, the Hugoton field of southwestern Kansas, and minor fields in Oklahoma and Kansas. Four distinctive areas of gas consumption may be recognized in the Illinois coal market area. They are:

1. The St. Louis district
2. Chicago
3. Cities of central Illinois
4. Nebraska-Iowa-southern Minnesota district.

From Monroe, Louisiana, a 22-inch pipe line carries gas to St. Louis, East St. Louis, and Alton. Population of the cities served by this line are as follows:

St. Louis	821,960
East St. Louis	74,347
Alton	30,151
Granite City	25,130
Total	951,588

The Hugoton field is connected by a 24-inch pipe line of the Panhandle Eastern Pipe Line Company with Indianapolis, Indiana, and enroute supplies cities in north central Missouri and central Illinois. The communities in these states served by this pipe line are:

In Illinois	*Population*
Jacksonville	17,747
Peoria	104,969
Peoria Heights	3,279
Pekin	16,129
East Peoria	5,027
Springfield	71,864
Decatur	57,510
Clinton	5,920
Urbana-Champaign	33,804
Danville	36,765
Total	353,014

In Missouri	*Population*
Boonville	6,435
Fayette	2,630
Fulton	6,705
Harrisonville	2,306
Macon	3,851
Mexico	8,290
Moberly	13,772
Total	43,389
Total Illinois and Missouri	396,403

Other communities in southwestern Missouri served by pipe line extensions from the Kansas and Oklahoma fields are Springfield, Carthage, Joplin, Neosho, Nevada, Kansas City, and St. Joseph. These communities are, however, practically outside of the competitive zone for Illinois coal.

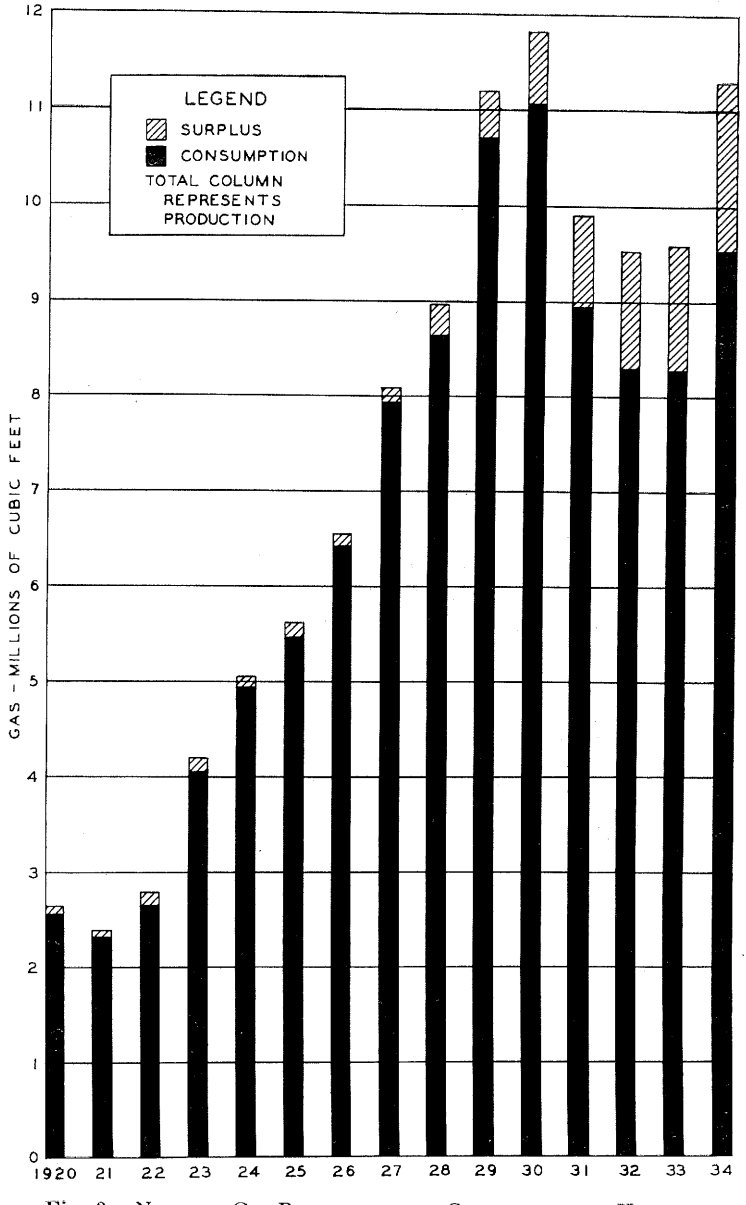


Fig. 3.—Natural Gas Production and Consumption in Kansas, Louisiana, Oklahoma, and Texas.

The Natural Gas Corporation of America has built a 24-inch pipe line from the Panhandle of Texas to Chicago. Only Chicago and suburbs are served by this line at present. The population of this metropolitan district is approximately 4,000,000.

The Northern Natural Gas Company taps the Panhandle field in Texas and serves or proposes extensions to existing pipe lines to serve 69 communities in eastern Nebraska, 38 communities in central Iowa, and 35 communities in Minnesota. LaCrosse, Wisconsin, would also be served by this system. Important cities now supplied by this system are Omaha and Lincoln, Nebraska, Council Bluffs, Sioux City, Des Moines, Fort Dodge and Mason City, Iowa, and Albert Lea, Minnesota. The lines now extend to Minneapolis and St. Paul, Rochester, and Winona, Minnesota.

In the western and central Dakotas, the Northern Minnesota Power Company supplies Williston, Bismark, and Rapid City from the gas field located near Miles City, Montana. This district is, however, outside of the limits of Illinois coal trade.

TABLE 24.—TOTAL CONSUMPTION OF NATURAL GAS, BY USES, IN THE ILLINOIS COAL MARKET REGION, EXCLUSIVE OF KANSAS, 1921-1934

(In millions of cubic feet)

Year	Domestic	Industrial Use			Total domestic and industrial	Equivalent in net tons of coal
		Total	Field use	Other industrial		
1921.....	4,663	2,446	1,328	1,118	7,109	284,336
1922.....	4,937	3,336	3,067	269	8,273	330,932
1923.....	6,291	4,092	3,833	259	10,383	415,320
1924.....	5,123	4,346	3,812	534	9,469	378,760
1925.....	5,100	4,441	3,915	526	9,541	381,648
1926.....	5,501	4,136	3,605	531	9,637	385,484
1927.....	5,618	4,802	3,577	1,225	10,420	416,784
1928.....	6,395	3,827	2,939	888	10,222	408,880
1929.....	8,188	11,746	2,907	8,839	19,934	797,360
1930.....	11,699	29,102	2,812	26,290	40,801	1,632,040
1931.....	16,141	33,312	2,045	31,267	49,453	1,978,120
1932.....	33,080	40,632	1,725	38,907	73,712	2,948,480
1933.....	35,877	50,013	1,555	48,458	85,890	3,435,600
1934.....	36,743	58,670	1,447	57,223	95,413	3,816,520

TABLE 25.—PRODUCTION, CONSUMPTION, AND SURPLUS OF NATURAL
(In millions

	1920	1921	1922	1923	1924
Production	270,962	242,283	279,132	420,561	508,224
Consumption	255,515	231,443	266,135	405,896	494,895
Surplus	15,447	10,840	12,997	14,665	13,329
Consumption by uses:					
Domestic[b]	47,816	43,601	43,635	44,224	46,291
Commercial					
Industrial	102,536	97,951	107,774	176,124	244,691
Field	105,163	89,891	114,726	185,548	203,913
Total	255,515	231,443	266,135	405,896	494,895
Industrial uses differentiated:					
Public Utility	9,564				
Carbon Black	18,100				
Petroleum Refineries					
Other Industrial	74,872				
Total	102,536				

[a] Data from annual reports of the U. S. Bureau of Mines, Chapters on Natural Gas.
[b] Includes commercial heating for the years 1920 to 1929 inclusive.

GAS FROM KANSAS, LOUISIANA, OKLAHOMA, AND TEXAS [a]
of cubic feet)

1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
563,694	657,331	810,244	896,316	1,122,428	1,181,967	991,162	954,570	960,872	1,130,055
548,627	642,362	793,357	865,477	1,071,074	1,106,742	894,176	831,565	827,754	953,780
15,067	14,969	16,887	30,839	51,354	75,225	96,986	123,005	133,118	176,275
46,637	50,208	57,321	68,604	93,549	68,104	65,819	64,576	56,414	87,641
.....	.....	.....	.....	.....	27,054	32,483	30,311	27,780	
274,379	326,217	385,049	444,894	564,512	566,310	438,832	385,315	409,179	468,112
227,611	265,927	350,987	351,979	413,013	445,274	357,042	351,363	334,381	398,027
548,627	642,362	793,357	865,477	1,071,074	1,106,742	894,176	831,565	827,754	953,780
.....	.....	.....	57,571	75,543	81,756	74,890	66,077	63,112	71,260
.....	.....	.....	167,419	254,821	261,644	187,857	161,285	179,096	222,535
.....	.....	.....	75,030	64,506	55,681	43,682	40,801	41,941	45,786
.....	.....	.....	144,874	169,642	167,229	132,403	117,152	125,030	128,531
.....	.....	.....	444,894	564,512	566,310	438,832	385,315	409,179	468,112

FACTORS UNDERLYING THE GROWTH OF IMPORTATION OF GAS INTO THE ILLINOIS COAL MARKET AREA

The record of increasing importation and consumption of natural gas in the Illinois coal market area described above raises the question as to the ultimate extent of utilization of this fuel and the effect of its introduction upon the competitive energy market. The answer to this question resolves itself into an analysis of potential supply of gas, extent and location of probable market outlets and the price at which this fuel can be delivered in the markets of the Upper Mississippi Valley.

Natural gas available to the Mississippi Valley region is produced in abundant quantities in the Mid-Continent, Gulf and Rocky Mountain fields and in limited quantities in the states of Kentucky, Tennessee, Indiana, Illinois, and Ohio, both as a by-product from oil wells and from fields which are primarily gas producers. The producers and consumers of energy materials in Illinois are particularly interested in conditions of supply and demand in Kansas, Louisiana, Oklahoma, and Texas from which states the natural gas consumed in the Illinois coal market area is obtained. In 1933, these four states operated 8997 gas wells and 126,650 oil wells the majority of which are also producers of enough gas to justify the efforts to save it. Production of gas in these states has increased enormously and, although consumption for field, industrial, and domestic use showed corresponding increases, nevertheless surplus gas available for export became more abundant. The comparative position of production, consumption and surplus for these states is shown in Table 25.

Table 25 and figure 3 disclose some interesting and significant characteristics of the natural gas industry in these states. Consumption has failed to keep pace with production with the result that in the fifteen-year period, the surplus of exportable gas has increased eleven fold. Consumption by uses within the area shows a rapid gain in industrial consumption, a gain proportional to production in field consumption, and a slower increase in domestic use. The question of interest is to what extent can the local market be expected to absorb the available supplies of natural gas and how much is available for export. One examination of trends in individual items of consumption may throw some light upon what may be expected in the immediate future.

Field use (for drilling, pumping, and operating gasoline recovery plants) has increased from 105,163 million in 1920 to 398,027 million cubic feet in 1934, or a ratio of 1:3.8. In the meantime, crude production in these states has increased from 287,091,000 bbls. to 522,377,000 barrels, or a ration of 1:1.8. Consumption of natural gas for field use has therefore increased more than the proportional output of crude petroleum. This may be due possibly to the substitution of gas for oil engines in field operations, increased pumping from wells and through pipe lines. That this increase will continue substantially is doubtful. While gasoline consumption is again showing an upward trend and, in 1935,

exceeded the previous high of 1929, it is not likely to continue the rate of increase experienced in the decade 1920-1929.

The rapid rise in industrial consumption also gives indications of deceleration when individual items of industrial use are examined. The most important of these in recent years has been carbon black. Consumption of natural gas, in these four states, in the manufacure of this product increased from 18,100 million cubic feet in 1920 to 222,910 million cubic feet in 1930. In that year the carbon black industry absorbed 39.4 per cent of the total industrial consumption. The explanation of this rapid rise is to be found in the nature of this particular industry. Carbon black is usually manufactured in districts where natural gas is produced in superabundance or in isolated localities which are too remote from pipe line systems to permit a connection with the producing well. The low value of the material (2.75 cents a pound in 1932) prohibits its manufacture from anything but gas with a low value at the well. Usually wherever pipe line connections can be made the value of the gas rises above the point where it is economical to continue its use in carbon black manufacture. For example, in 1932, an average of 1.44 pounds of carbon black valued at 2.75 cents was manufactured from 1000 cubic feet of gas, or about 4 cents worth of material per thousand cubic feet. After deducting manufacturing costs, it is evident that only a gas of low value can be used. The history of carbon black manufacture shows a migration from West Virginia to the mid-continent states as the new gas fields were opened and as increasing demand for heating purposes served to increase the value of gas in the older fields. The trend of natural gas utilization in carbon black manufacture by states, since 1920, is shown in Table 26.

The rapid increase in carbon black production resulted in a glutted market in 1930 with the result that production declined 29 per cent by 1933 in spite of a slight increase in demand. Combined domestic and foreign sales in 1933 totaled 374,644,000 pounds while stocks held by producers on December 31, 1933 amounted to 151,993,000 pounds. The resulting surfeit, together with opening up of new gas fields in Wyoming, Montana, and the Turner Valley in Canada, many of which have no pipe line connections and must find an outlet partially in carbon black manufacture, will tend to bring about a reduction in this industry in the Mid-Continent field. The opening of long distance pipe lines from the Monroe field in Louisiana, the Hugoton field in Kansas, and the Panhandle of Texas offer an outlet for the export of this surplus gas to the Upper Mississippi Valley.

TABLE 26.—TREND OF NATURAL GAS CONSUMPTION IN CARBON BLACK MANUFACTURE, BY PRINCIPAL STATES, 1920-1933 [a]
(In billions of cubic feet)

State	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933
West Virginia	18.6	15.5	12.1	13.7	9.6	7.1	2.6	1.9	0.5	0.3	[e]	.....	.....	.....
Louisiana	18.1	32.1	38.0	83.0	127.8	109.4	99.1	96.2	104.7	103.8	85.2	52.0	39.1	40.9
Wyoming	3.7	0.9	[c]	[c]	[c]	3.0	3.6	4.4	0.5	[d]	[d]	[d]	[d]	[d]
Montana	[b]	[c]	[c]	[c]	[c]	[b]	[b]	2.0	1.8	2.1	0.7	0.2	.....	.....
Oklahoma	.....	0.6	1.2	4.3	3.4	.....	.....	.....	.....	[d]	[d]	[d]	[d]	[d]
Kentucky	[b]	1.5	2.3	5.9	6.2	4.0	3.1	3.2	0.2	.....	.....	.....	.....	.....
Texas	.....	.....	.....	2.1	9.6	16.9	22.0	35.5	62.7	151.0	176.4	135.7	122.2	138.2
Utah	.....	.....	.....	.....	.....	.....	.....	0.9	1.1	[c]	0.4	[d]	.....	.....
Other States	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	4.1	3.8	3.9	7.3	7.0	7.7
Total	.....	.....	.....	.....	.....	.....	.....	.....	175.6	261.0	266.6	195.2	168.3	186.8

[a] Data from U. S. Bureau of Mines, Mineral Resources of the United States, Annual chapters on Natural Gas.
[b] Included with Wyoming.
[c] Included with Oklahoma.
[d] Other states.
[e] Not reported.

The third item in the consumption of natural gas for which data are separably available is the electric utility market. The rapid rise between 1920 and 1930 and the probable stabilization of consumption in this field is indicated by the data in Table 27.

TABLE 27.—CONSUMPTION OF FUEL BY ELECTRIC UTILITIES IN KANSAS, LOUISIANA, OKLAHOMA, AND TEXAS IN 1920, 1930, 1931, 1932, AND 1934

	1920	1930	1931	1932	1934	Per Cent in 1934
Coal, tons	961,124	1,116,316	935,444	818,549	955,001	
Fuel oil barrels	4,559,047	1,382,290	835,148	882,792	742,092	
Natural gas M cu. ft.	9,563,545	81,755,512	74,889,977	66,077,369	71,259,589	
FUEL OIL AND NATURAL GAS CONVERTED TO COAL EQUIVALENT						
Coal, tons	961,124	1,116,316	935,444	818,549	955,001	24.2
Fuel oil, coal equivalent[a]	1,086,000	329,000	198,000	210,190	176,688	4.4
Natural gas, coal equivalent[b]	382,400	3,270,000	3,000,000	2,643,100	2,850,383	71.4

[a] Fuel oil converted to coal equivalent on a basis of 4.2 barrels of oil per ton of coal.
[b] Natural gas converted to coal equivalent on a basis of 25,000 cubic feet of gas per ton of coal.

This table reveals the changes that have taken place in electric utility fuel consumption from 1920 to 1934. While coal consumption has remained practically constant, fuel oil has declined and natural gas has increased tremendously. Not only has fuel oil yielded to natural gas but practically all of the increase in total fuel consumption in 1930 and 1931 over the 1920 level is accounted for by natural gas. Continued increases in gas utilization in the electric utility market will depend upon a further displacement of coal and fuel oil, and increases of electric power output. Neither one of these factors is likely to be large enough to bring about a need for increased use of gas in substantial quantities.

SUMMARY OF NATURAL GAS CONSUMPTION IN THE LOCAL MARKET

The natural gas market in these states from which the Illinois coal market area obtains its supply of gas appears to be reaching the point of saturation. Nearly all cities and communities of 5000 inhabitants or more are now connected with natural gas lines. Consumption for domestic purposes has shown a considerable increase since 1927 but appears to be reaching a point of stabilization. Rapid increases in consumption for carbon black manufacture are the result of the combined factors of a decline of the industry in West Virginia, a pronounced growth in automobile tire manufacture in the past decade and in an output far in excess of market demand, especially in 1929 and 1930. Until surplus stocks of this material are sold and further production is necessary, this industry will probably be severely curtailed. This has already occurred in 1931 and 1932. When production is resumed, it will probably occur in states which have abundant supplies of gas without adequate markets for disposal through pipe line connec-

tions. Future production may be attempted in Wyoming, Montana, and Alberta, Canada. A program of curtailment in the crude oil industry will have a corresponding effect upon the consumption of natural gas for field operations. With a decrease in the rate of growth of gas consumption, the question of disposal of surplus gas becomes more critical. For this disposal six long distance outlets are provided, four of which enter into the Illinois coal market area.

MARKETING OF SURPLUS GAS FROM THE MID-CONTINENT FIELD

The potential reserves of natural gas appear to exceed by far the demands of the local market. The quantities of gas available in the United States are not measurable with the meagre data that is now on hand. "An estimate published recently credits the Kettleman Hills field in California with reserves of 37,500,000,000,000 cubic feet of natural gas, and the other developed fields of California with aggregate reserves of similar size. Enormous proven gas reserves also exist in the known fields of the Rocky Mountain States; of Kansas, Oklahoma, Texas, Louisiana, Arkansas, Mississippi, Kentucky, Ohio, and West Virginia; and other major areas appear to be in process of development in Michigan, in Pennsylvania and New York. What our undiscovered gas fields will yield, and what the deeper sands in some of the developed fields will produce is not now calculable, but I believe that the country's available gas reserves will amount to not less than 100,000,000,000,000 cubic feet and may greatly exceed 200,000,000,000,000 cubic feet."[1]

The minimum figure represents an equivalent of 4,000,000,000 tons of coal and the maximum figure more than 8,000,000,000 tons. If we credit half of the smaller figure to the Mid-Continent field, we arrive at a total of gaseous energy equivalent of 2,000,000,000 tons of coal available in this area and through long distance pipe line also available to the Illinois coal market area. Even allowing for the possibility that the above estimate should prove to be excessive, it appears that the gas reserves are ample to supply local needs in the Mid-Continent and provide a substantial quantity for the Illinois coal market area for some time to come.

The immediate concern, therefore, of the coal industry in Illinois is to find out at what rate the gas will be piped into this market territory. The maximum supply is, of course, limited by the carrying capacity of the pipe lines entering the market area.

Various qualifications and limitations, economic and technical, limit consumption below the potential quantities that the pipe lines can deliver. The critical factors in determining how much of the potential delivery capacity of the pipe lines will actually be marketed in this territory are:

(1) The annual capacity factor that will be built up.

(2) The fuel markets that can be obtained.

1 Thom, W. T., Relationship of bituminous coal to oil and gas: Proceedings of the Third International Conference on Bituminous Coal, 1931, p. 84.

Annual capacity factor is here defined as the ratio of the average yearly load to the capacity of the pipe line. This capacity factor will be, theoretically, 100 per cent, if markets are available to consume the full capacity of the line each day of the year and 24 hours of the day. In actual operation such conditions do not exist.

The opposite extreme of this ideal condition is a condition where a pipe line serves only a house heating load. Demand would fluctuate widely from almost zero in the summer months to a peak load in the midst of winter. Even more unfavorable than the seasonal fluctuation would be the change in demand from day to day with the wide variations in temperature that are characteristic of climate in this area. A house heating load alone is generally recognized as uneconomical and an attempt is made to secure more balanced consumption by adding a lower price industrial load. Certain industries such as glass and pottery manufacure, printing, laundries, bakeries, or heat treatment operations where a gaseous fuel is either necessary or highly desirable, are ideal industrial consumers of gas. In some instances, it is possible for the gas producer to arrange with public utilities to purchase surplus gas on off-peak periods and in seasons of low domestic demand. This involves the necessity on the part of the public utility to maintain an auxiliary fuel plant burning either coal or fuel oil, and correspondingly enables them to secure low rates on gas. Low rates to intermittent consumers must therefore be offset by higher rates to domestic and small industrial consumers who must have continuous service.

SCHEDULE OF RATES FOR NATURAL GAS IN CHICAGO

In order to secure as large a capacity factor as possible, specially low rates are offered to industries which can make use of gas during the periods of low annual or daily demand. A comparison of rates for different types of services in Chicago will serve to illustrate this. Under the order of the Illinois Commerce Commission effective July 1, 1933, rates are prepared for twelve service classifications of which four are selected for purposes of illustration.

Service rates selected for illustration are:

(1) Residential service.
(2) Water heating service.
(3) Large volume service.
(4) Large volume interruptible service.

Sechedule of rates

Residential Service

Therms used in any one month	*Charge*
For the first 2 therms	58.0 cents
For the next 24 therms	15.8 cents per therm
For all over 26 therms	7.0 cents per therm

Water heating service

The rates under this classification for gas used during the months of October, November, December, January, February, March and April shall be:

25.0 cents per therm.

The rates under this classification for gas used during the months of May, June, July, August, and September shall be:

6.6 cents per therm.

Large Volume Service

Subject to certain limitations governing the quantity of gas to be supplied on Sundays and certain holidays, the rates for this service are as follows:

Therms used in any one month	*Charge*
For the first 1,000 therms or less	$107.50
For the next 4,000 therms	8.0 cents per therm
For the next 95,000 therms	5.0 cents per therm
For all over 100,000 therms	4.5 cents per therm

Large Volume Interruptible Service

Subject to conditions of plant location, consuming capacity of steam boilers, and uses of steam, stipulated by the gas company, together with the right to discontinue delivery temporarily upon short notice, and other conditions, the rate for this type of service is 12.5 cents per million British thermal units.

The purpose of the schedules in the low rate classifications is to increase the daily and yearly capacity factor by offering unusually low rates in off-peak periods and discouraging the use of gas in these classifications during the daily and annual peak load periods. Thus in the large volume interruptible service class, a public utility or other steam generating plant is offered surplus gas at an equivalent of about $3.00 a ton for 12,500 B. t. u. coal on an assumed basis of equal efficiency in combustion. If gas can be burned more efficiently than coal, a still greater advantage accrues to the former. The domestic consumer, meanwhile, pays a minimum of $17.50 for heat equivalent to a ton of coal at equal combustion efficiencies.

The extent to which industry in the Chicago area will take advantage of the rates now authorized is problematical.

CHAPTER V

WATER POWER IN THE ILLINOIS COAL MARKET AREA

Under modern conditions of power production the contribution of water power resources to the available power supply is practically limited to the generation of electrical energy. A small, but declining proportion of mechanical hydraulic power is still produced mainly in the older water power districts of the East but it is negligible in the Upper Mississippi Valley. The meagerness of water power resources in this latter area is evident from the limited contribution to the public utility output of these states and the small amounts that are considered potentially available for further development. An estimate of the United States Geological Survey places these potential resources at horsepower, distributed among the states as follows:

TABLE 28.—POTENTIAL WATER POWER RESOURCES OF THE STATES COMPRISING THE ILLINOIS COAL MARKET AREA [a]

State	Available 90 per cent of the time		Available 50 per cent of the time	
	Horsepower	Percentage of nation	Horsepower	Percentage of nation
Illinois	189,000	0.54	361,000	0.66
Wisconsin	285,000	0.82	480,000	0.87
Minnesota	203,000	0.58	401,000	0.73
Iowa	169,000	0.49	395,000	0.72
Missouri	67,000	0.19	152,000	0.27
North Dakota	82,000	0.23	193,000	0.35
South Dakota	63,000	0.18	110,000	0.20
Nebraska	183,000	0.53	342,000	0.62
Kansas	104,000	0.30	251,000	0.46
Total	1,345,000	3.86	2,685,000	4.88

[a] United States Geological Survey, Potential Water Power Resources of the United States, Mimeograph release, 1924.

If these resources were developed to the capacity indicated in the estimates above, available 90 per cent of the time, the potential output in kilowatt hours at 40 per cent capacity factor would be about 3,500,000,000 kilowatt hours. This is slightly more than the maximum output attained by existing water power plants in 1928. However, complete development of the physically potential water powers is not likely to occur. The economic feasibility of many of these small

and scattered waterpower sites is questionable in the face of competition from increasingly efficient steam stations. Moreover, many of the available waterpowers are in northern Wisconsin and Minnesota and in remote sections of the prairie states where transmission costs to consuming centers would add to the delivered cost of electric power.

An indication of the trend of water power development in the immediate future may be gained by an examination of the application before the Federal Power Commission, as reported in their eleventh annual report the year ending June 30, 1931 (Table 29).

TABLE 29.—DISTRIBUTION OF ACTIVE PROJECTS BY STATES, JUNE 30, 1931 [a]

	Number of projects	Primary horsepower	Installed capacity horsepower
Illinois	2	42,350	55,300
Wisconsin	4	28,941	67,420
Minnesota	4	19,290	48,200
Iowa	1	728	4,200
Missouri	6	105,330	483,000
North Dakota	.....	0	0
South Dakota	3	1,000	1,600
Nebraska	.....	0	0
Kansas	.....	0	0
Total	20	197,639	659,720

[a] Eleventh Annual Report of the Federal Power Commission, 1931, p. 19.

Applications before the Federal Power Commission probably indicate the sites that, under present conditions, can be profitably developed. When completely installed, this added capacity can generate about 500,000,000 kilowatt hours at a 40 per cent capacity factor. This is one-sixth of the water power production in the maximum year of 1928 and would represent the displacement of about 400,000 tons of coal.

The actual hydro-electric power output since 1920 is given in Table 30.

Wisconsin, Iowa, Minnesota, and Illinois rank as most important. Appreciable gains in 1930 were registered only in Missouri with the opening of the new plant at Bagnell on the Osage River, while the growth in Wisconsin and Minnesota reflects the periodical development of small sites. The total output in 1933 was 19.5 per cent of all electric utility production in the states. Installed water power capacity in these states as of December 31, 1933, is given in Table 31.

TABLE 30.—COAL-EQUIVALENT OF HYDRO-ELECTRIC POWER PRODUCTION, 1920-1934

Year	Hydro-electric power[b] output in K. W. Hrs. (in thousands)	Pounds of coal per K. W. Hrs.	Coal equivalent (in thousands of tons)
1920	1,814,106	3.0	2,721
1921	1,738,413	2.7	2,350
1922	1,738,895	2.5	2,175
1923	1,819,802	2.4	2,190
1924	2,121,735	2.2	2,330
1925	2,132,361	2.1	2,240
1926	2,609,474	1.95	2,530
1927	2,848,628	1.84	2,625
1928	3,074,376	1.76	2,700
1929	2,814,435	1.69	2,388
1930	2,534,058	1.62	2,050
1931	2,405,837	1.55	1,860
1932	2,637,178	1.52	2,000
1933	2,524,246	1.47	1,855
1934	2,227,089	1.45	1,415

[a] U. S. Geological Survey Water Supply Paper 579, Table 43; and U. S. Geological Survey Monthly Report of Electric Power Production, Division of Power Resources.
[b] For Illinois, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas.

TABLE 31.—INSTALLED CAPACITY OF GENERATORS IN POWER PLANTS GENERATING ELECTRICITY FOR PUBLIC USE, DECEMBER, 1934[a]
(In kilowatts)

State	Water power alone	In combination with other forms of power	Total
Illinois	42,315	3,910	46,225
Wisconsin	220,458	6,843	227,301
Minnesota	151,530	2,338	153,868
Iowa	147,400	6,903	154,303
Missouri	149,745	0	149,745
North Dakota	0	0	0
South Dakota	4,000	0	4,000
Nebraska	8,865	3,905	12,770
Kansas	6,415	1,967	8,382
Total	730,728	25,866	756,594

[a] Monthly and Annual Production of Electricity for Public Use in the United States, in 1934: U. S. Geol. Survey, Mimeograph release of April 20, 1935.

CHAPTER VI

ENERGY MARKET IN THE ELECTRIC UTILITY INDUSTRY

FUEL CONSUMPTION IN THE ELECTRIC UTILITY INDUSTRY

The statistical summary of the public utility fuel market for 1934 shows that 8,463,349 tons of coal, 810,192 barrels of fuel oil and 22,973,186 thousand cubic feet of natural gas were used by public utilities in the Illinois coal market area. If the fuel oil is converted into bituminous coal equivalent on a basis of 4.2 barrels of oil to a ton of coal and 25,000 cubic feet of natural gas are considered the equivalent of a ton of coal, the distribution of fuels used in the production of electrical energy is as follows:

	Tons	Per cent
Coal	8,463,349	88.4
Fuel oil	192,903	2.0
Natural gas	918,927	9.6
Total	9,575,179	100.0

In addition to the fuel-generated electrical energy there is also an output of approximately 16 per cent of the total by water power. The distribution of fuel and hydro-electrical energy for 1934 is given in Table 32.

The outlook for the coal market among public utilities is conditioned upon a complex and interlocking group of factors, the principal ones of which may be enumerated as follows:

(1) Development of potential water power sites.
(2) Trends in the use of fuel oil and natural gas.
(3) Advances in fuel economy.
(4) Future trend of electric power consumption.

POTENTIAL WATER POWER RESOURCES OF THE ILLINOIS COAL MARKET AREA

The potential growth of hydro-electric installations in the Illinois coal market area has been analyzed in a previous chapter and only the conclusions will be repeated here. On the basis of applications before the Federal Power Commission, the increase is estimated at 500,000,000 kilowatt hours, the approximate equivalent of 400,000 tons of coal at present levels of fuel efficiency. This is equal to 4 per cent of the present average of coal consumption. The most important of the projected installations are located in Missouri in which area the market for Illinois coal is of minor importance.

TABLE 32.—PRODUCTION OF ELECTRICITY IN KILOWATT-HOURS IN THE ILLINOIS COAL MARKET AREA, 1920-1934 [a]

Year	Illinois	Wisconsin	Minnesota	Iowa	Missouri	North Dakota	South Dakota	Nebraska	Kansas	Total
Total production of electricity (In thousands of kilowatt hours)										
1920	3,042,691	960,303	703,315	1,016,766	698,225	28,259	48,014	247,195	437,652	7,182,420
1921	2,984,134	916,819	733,124	989,209	722,320	31,484	51,264	264,729	415,230	7,108,313
1922	3,482,932	1,093,562	787,589	1,041,953	871,026	32,314	56,084	283,575	495,921	8,144,956
1923	4,066,606	1,268,612	858,220	1,110,326	1,060,884	36,116	62,056	316,821	532,143	9,311,784
1924	4,665,472	1,429,751	869,866	1,175,068	888,755	39,296	65,909	337,902	557,370	10,029,389
1925	5,269,477	1,542,251	1,045,684	1,195,315	865,802	39,050	74,875	366,266	666,664	11,065 384
1926	5,930,399	1,820,903	1,040,191	1,344,978	912,503	47,555	80,342	394,832	766,413	12,338,116
1927	6,318,563	1,936,196	1,054,094	1,410,992	958,452	56,541	88,121	431,001	842,252	13,096,212
1928	6,965,681	2,106,423	1,065,262	1,520,639	990,792	85,385	105,887	464,291	893,449	14,197,809
1929	7,369,263	2,275,608	1,202,307	1,499,476	1,220,661	104,979	107,738	533,235	1,007,049	15,320,316
1930	6,851,464	2,158,580	1,310,836	1,574,011	1,269,045	124,667	114,260	574,839	1,014,461	14,992,163
1931	6,332,875	1,983,061	1,303,864	1,498,512	1,304,423	137,196	102,201	595,190	931,830	14,199,152
1932	5,452,340	1,835,878	1,152,333	1,527,013	1,210,084	136,652	87,574	550,640	869,849	12,822,363
1933	5,631,553	1,813,114	1,161,727	1,394,138	1,289,317	138,975	85,667	555,654	879,272	12,949,417
1934	6,089,763	1,948,767	1,224,361	1,437,016	1,205,461	157,614	98,469	611,099	992,425	13,764,975
Production of electricity by fuels (In thousands of kilowatt hours)										
1920	2,858,036	497,051	293,198	354,335	652,181	28,259	33,452	234,058	417,144	5,368,314
1921	2,801,235	464,722	344,782	364,735	681,082	31,484	39,766	248,095	393,999	5,369,900
1922	3,291,105	594,541	445,100	412,010	841,776	32,314	44,506	266,729	477,971	6,406,061
1923	3,870,414	730,584	530,598	465,254	1,005,837	36,116	52,434	294,083	506,662	7,491,982
1924	4,469,239	743,252	445,909	479,134	831,333	39,296	55,035	313,338	531,118	7,907,654
1925	5,071,021	926,067	510,741	523,916	817,999	39,050	64,087	337,166	642,976	8,933,023
1926	5,707,267	949,994	452,993	566,610	838,138	47,555	72,023	360,757	733,305	9,728,642
1927	6,077,062	979,242	380,824	602,232	875,885	56,541	75,895	396,012	803,891	10,247,584
1928	6,703,765	1,051,149	353,449	633,025	915,979	85,385	94,112	429,658	856,911	11,123,433
1929	7,113,511	1,305,343	546,429	712,771	1,148,528	104,979	94,060	499,222	981,038	12,505,881
1930	6,592,406	1,318,487	687,704	891,740	1,216,247	124,667	100,551	539,848	986,455	12,458,105
1931	6,084,282	1,206,421	804,338	866,760	1,173,930	137,196	93,007	558,391	903,074	11,827,399
1932	5,210,410	1,043,574	671,269	764,728	922,754	136,652	75,629	513,636	844,125	10,182,797
1933	5,385,013	1,099,905	714,424	761,973	888,046	138,975	75,185	508,226	853,424	10,425,171
1934	5,860,661	1,174,977	886,388	862,449	955,594	157,614	90,642	573,613	975,948	11,537,886

Hydro-electric power output by states [b]

(In thousands of kilowatt hours)

1920	184,655	463,252	410,117	662,431	46,044	0	14,562	12,537	20,508	1,814,106
1921	182,899	452,097	388,342	624,474	41,238	0	11,498	16,634	21,231	1,738,413
1922	191,827	499,021	342,480	629,943	29,250	0	11,578	16,846	17,950	1,738,895
1923	196,192	538,028	327,622	645,072	55,047	0	9,622	22,738	25,481	1,819,802
1924	196,233	686,499	423,957	695,934	57,422	0	10,874	24,564	26,252	2,121,785
1925	198,456	616,184	534,943	671,399	47,803	0	10,788	29,100	23,688	2,132,361
1926	223,132	870,909	587,198	778,368	74,365	0	8,319	34,055	33,108	2,609,474
1927	241,501	956,954	673,270	808,760	82,567	0	12,226	34,989	38,361	2,848,628
1928	261,916	1,055,274	711,813	887,614	74,813	0	11,775	34,633	36,538	3,074,376
1929	255,752	970,265	655,878	786,305	72,133	0	13,678	34,013	26,011	2,814,435
1930	259,058	840,093	623,132	682,271	52,798	0	13,709	34,991	28,006	2,534,058
1931	248,593	776,640	499,526	631,752	140,493	0	9,194	36,799	28,756	2,372,113
1932	241,930	792,304	481,064	762,205	287,330	0	11,945	36,984	25,724	2,639,566
1933	246,540	713,209	447,303	632,165	401,271	0	10,482	47,428	25,848	2,524,246
1934	229,102	773,790	337,973	574,567	249,867	0	7,827	37,486	16,477	2,227,089

[a] Data compiled from Water Supply Paper 579, Power Capacity and Production in the United States, U. S. Geological Survey, 1928, and from the annual mimeographed reports on "Monthly and Annual Production of Electricity for Public Use in the United States, in 1927 to 1934."

[b] Data for 1920-1926 inclusive from Water Supply Paper 579, Power Capacity and Production in the United States, U. S. Geological Survey, Table 41, pp. 129-166, 1928. Data for succeeding years obtained from annual mimeographed reports of the Division of Power Resources of the United States Geological Survey.

NATURAL GAS AND FUEL OIL COMPETITION

Fuel oil and natural gas are only minor contributors to the fuel used by electric utility plants in this area. Indeed fuel oil has declined from a high figure of 2,332,148 barrels in 1922, representing 8.2 per cent of the total fuel consumption, to 769,867 barrels or 2.6 per cent of total fuel used. This decline has occurred mainly in Missouri and Kansas where competition from natural gas since 1928 has been a significant factor. These two states were also the largest users of fuel oil and accounted for 50 to 90 per cent of the total consumption in this area in different years. Consistent increases in fuel oil consumption have occurred in Illinois, Wisconsin, Minnesota, Iowa, the Dakotas and Nebraska, but the aggregate consumption is small and the increase is of small significance. (Table 33).

Natural gas consumption is important only in Iowa, Missouri, North Dakota, Nebraska, and Kansas. The principal effect of natural gas utilization has been a substitution for fuel oil rather than coal, with the possible exception of Kansas where coal consumption has also experienced a severe decline. It is significant, however, that the principal competition has been with Missouri, Kansas, and Oklahoma coal fields (Table 33).

The future trend in fuel oil utilization is probably toward a slow decline. The efforts of the oil industry to adjust production to market demand for motor fuels, coupled with an increasing percentage of gasoline recovery from the crude will tend to decrease the available supply of fuel oil. The decline will probably be slow but the public utility plants will probably be among the first to revert to coal utilization.

Natural gas consumption has shown a rapid increase since 1927 (Table 33) but is showing signs of becoming stabilized. The limits to natural gas consumption in the public utility field are probably fixed by the sizes of the market in or near the producing fields where gas is cheap. In the markets remote from the producing fields, the delivered cost of natural gas necessitates confining it to the higher priced markets such as domestic consumption or specialized industries requiring gaseous fuel in the process. Occasionally, natural gas may be used by public utilities in off-peak periods but this has not become an important factor.

FUEL EFFICIENCY

Of especial interest to the coal producer is the trend toward increased economy in fuel utilization. Efficiency in fuel utilization has made astonishing advances since 1902, when the average coal consumption per kilowatt-hour of electricity was 6.6 pounds. By 1920 the consumption was cut to 3.56 pounds in the Illinois coal market area and each year thereafter it steadily declined. The record from 1920 to 1932 is shown in Table 34. A brief calculation will show that the quantity of fuel used in 1932 on a basis of 1920 performance, would have been 18,000,000 tons or an excess of 10,000,000 tons over the actual consumption.

The question naturally arises: To what extent will increasing economy effect further reduction in the coal requirements per kilowatt-hour? Achievements of 1 pound per kilowatt hour or better have been recorded by large central stations. The Columbia station of the Columbia Power Company on Ohio River below Cincinnati achieved a record of 1 kilowatt-hour of 12,495 B. t. u.'s, or somewhat less than a pound of high grade bituminous coal. This fuel economy is accomplished by improvements in the design of power machinery, as well as in the method of firing under boilers. Higher pressures and temperatures, larger power units, mechanical stoking, and the use of powdered coal have been the chief contributing elements toward greater fuel economy.

The attainments of a large modern power plant cannot, of course, be achieved on the average. Many small power plants exist which cannot take advantage of heat economizers, mechanical stokers or high-pressure boilers. This is particularly true in the smaller cities of the agricultural sections where the size of the stations is sharply limited by market conditions. The present level of 1.6 pounds per kilowatt hour in the Illinois coal market area will be gradually reduced as new stations replace obsolete units and consolidations are effected, but from now the reduction will be slow. If an average level of 1.5 pounds per kilowatt hour be achieved eventually, it would mean a difference of about 1,300,000 tons of coal for an output of electricity equal to that of 1934.

FUTURE TREND OF THE ELECTRICAL MARKET

The demand for electric power increased at an average rate of 10 per cent in the decade 1920 to 1929. This period was characterized by (1) extensive replacement of private steam, hydraulic and steam-electric power plants in the manufacturing industries by purchased power and (2) rapid enlargement of the domestic market both in the number of customers served and the kilowatt-hour consumption per customer.

In the manufacturing industries, electrification has made continued progress, as illustrated by the figures below, based on Census data pertaining to total horsepower used.

	1914	1919	1929
	Per cent	*Per cent*	*Per cent*
Operated by purchased power	14.3	26.6	38.2
Individually generated power	18.1	19.2	22.4
Total electrification	32.4	44.8	60.6
Mechanical power	67.6	55.2	39.4
Total	100.0	100.0	100.0

TABLE 33—FUEL CONSUMED BY ELECTRIC UTILITIES IN THE ILLINOIS COAL MARKET AREA, 1920-1934[a]

Year	Illinois	Wisconsin	Minnesota	Iowa	Missouri	North Dakota	South Dakota	Nebraska	Kansas	Total
Coal (In net tons)										
1920	4,394,060	867,538	520,515	1,004,340	1,190,148	179,132	82,199	451,487	472,771	9,162,192
1921	3,985,688	678,447	507,949	870,621	1,092,616	168,596	86,853	427,650	282,892	8,101,312
1922	4,416,902	744,737	579,359	881,948	1,160,644	165,384	86,631	368,458	233,831	8,637,894
1923	5,078,954	862,323	706,591	988,182	1,450,607	173,064	92,718	384,601	248,473	9,985,513
1924	5,361,059	767,778	590,107	940,632	1,194,322	160,328	90,279	406,555	252,713	9,763,773
1925	5,577,318	842,354	584,554	927,196	1,144,763	154,918	102,457	438,363	314,875	10,086,798
1926	5,888,776	809,749	524,528	894,026	1,075,087	167,790	112,658	430,372	368,884	10,271,870
1927	5,811,818	803,315	431,020	880,169	1,061,717	196,572	118,792	446,371	362,384	10,112,158
1928	6,087,841	814,079	403,121	876,546	1,040,466	231,724	125,088	479,560	324,089	10,382,514
1929	6,221,907	975,596	546,305	961,253	1,220,430	272,835	126,288	541,654	361,733	11,228,041
1930	5,551,563	955,597	659,781	1,046,489	1,248,197	288,330	126,789	518,383	307,935	10,698,064
1931	4,882,230	839,824	301,185	971,004	1,205,979	262,832	121,504	415,605	254,553	9,654,716
1932	3,855,573	672,886	591,284	815,134	846,249	261,043	100,367	323,915	229,947	9,829,277
1933	4,109,587	707,005	523,872	740,973	768,206	251,983	91,256	306,383	224,438	7,723,703
1934	4,493,323	792,859	597,750	799,358	844,153	284,804	89,412	336,712	224,978	8,463,349
Fuel Oil (In barrels of 42 gallons each)										
1920	3,564	4,682	5,337	9,555	448,837	2,273	24,056	79,976	821,383	1,399,703
1921	2,484	6,944	5,528	12,013	225,840	1,607	23,528	102,470	1,056,152	1,436,566
1922	32,727	2,813	16,195	41,630	544,555	2,690	28,453	302,496	1,360,589	2,332,148
1923	11,244	3,779	11,517	24,342	280,172	3,191	34,909	243,081	1,314,958	1,927,193
1924	4,905	5,114	9,594	26,457	207,332	3,615	41,092	189,919	1,063,291	1,551,319
1925	2,466	9,430	5,273	34,483	195,182	3,869	39,452	96,513	759,526	1,146,194
1926	7,364	10,198	6,692	33,849	149,762	2,678	43,034	78,445	659,737	991,759
1927	27,101	9,202	6,911	41,694	103,818	1,855	37,845	84,708	538,703	851,837
1928	36,099	24,273	8,197	59,553	173,244	4,993	41,972	99,188	517,575	995,094
1929	29,344	18,105	12,967	65,461	205,579	4,445	43,863	137,306	476,283	993,358
1930	32,259	29,883	18,050	83,271	194,726	13,229	42,383	138,988	333,134	885,923
1931	31,614	30,231	32,090	98,044	172,319	9,112	50,661	171,842	307,945	903,858
1932	35,539	28,971	32,786	117,844	165,003	12,034	53,348	176,685	323,410	945,620
1933	34,839	27,338	27,456	109,492	148,032	8,797	51,914	178,034	183,965	769,867
1934	32,754	32,401	29,578	111,696	152,700	12,477	66,012	163,107	209,467	810,192

Natural Gas

(In thousands of cubic feet)

1920	0	0	0	0	0	0	0	0	1,481,295	1,481,295
1921	0	0	2,100	0	10,339	0	0	0	2,160,040	2,172,479
1922	0	0	0	0	3,858	0	0	0	3,210,238	3,214,096
1923	0	0	110	0	0	2,300	0	0	2,942,349	2,944,759
1924	0	0	0	0	0	0	0	0	3,785,144	3,785,144
1925	0	0	0	0	0	0	0	0	5,383,539	5,383,539
1926	0	0	0	0	0	0	0	0	5,916,847	5,916,847
1927	0	0	0	0	0	0	0	0	8,698,147	8,698,147
1928	0	0	0	0	0	0	0	0	8,838,113	8,838,113
1929	0	0	0	0	455,444	0	0	0	11,287,668	11,743,112
1930	0	0	0	0	966,458	0	0	262,583	12,636,041	13,865,082
1931	0	0	0	357,796	1,106,448	175,405	0	1,083,586	11,314,491	14,037,726
1932	0	0	324,258	1,313,519	1,867,268	167,175	61,849	1,726,332	9,829,277	15,288,277
1933	0	0	1,009,906	2,259,256	2,218,191	154,656	127,721	1,701,000	10,799,942	18,270,672
1934	358,098	0	1,117,172	3,249,019	2,668,257	205,385	473,197	2,261,618	12,640,440	22,973,159

[a] Data compiled from Water Supply Paper 579, Power Capacity and Production in the United States, U. S. Geological Survey, 1928, and from the annual mimeographed reports for "Monthly and Annual Production of electricity for public use in the United States in 1927, 1928, 1929, 1930, 1931, and 1932."

TABLE 34.—COMPARATIVE FUEL CONSUMPTION AND FUEL EFFICIENCY IN THE ILLINOIS COAL MARKET AREA, 1920-1933 [a]

Year	(1) Coal used net tons	(2) Fuel oil barrels of 42 gal.	(3) Coal equivalent of fuel oil—net tons (1 net ton 4.2 bbls.)	(4) Natural gas M cubic feet	(5) Coal equivalent of nat. gas—net tons (1 ton = 25,000 cu. ft.)	(6) Total fuel used, coal and equivalent fuels (Columns 1, 3 and 5)	K. W. Hrs. output by fuels, in thousands	Pounds of fuel per K. W. Hr.
1920	9,162,192	1,399,703	333,262	1,481,295	59,252	9,554,706	5,368,314	3.56
1921	8,101,312	1,436,566	342,040	2,172,479	86,900	8,530,252	5,369,900	3.18
1922	8,637,894	2,332,148	531,464	3,214,096	128,564	9,297,922	6,406,061	2.90
1923	9,985,513	1,927,193	458,855	2,944,759	117,790	10,562,158	7,491,982	2.71
1924	9,763,773	1,551,319	368,885	3,785,144	151,406	10,284,064	7,907,654	2.60
1925	10,086,798	1,146,194	272,903	5,383,539	215,342	10,575,043	8,933,023	2.36
1926	10,271,870	991,759	236,133	5,916,847	236,674	10,744,677	9,728,642	2.21
1927	10,112,158	851,837	202,818	8,698,147	347,926	10,662,902	10,247,584	2.08
1928	10,382,514	995,094	234,546	8,838,113	353,525	10,970,585	11,123,433	1.97
1929	11,228,041	993,358	236,513	11,743,112	469,924	11,934,478	12,505,881	1.91
1930	10,698,064	885,923	210,934	13,865,082	554,603	11,456,401	12,458,105	1.84
1931	9,654,716	903,858	215,204	14,037,726	561,509	10,431,429	11,827,399	1.72
1932	7,696,398	945,620	225,140	15,288,513	611,540	8,533,078	10,182,797	1.68
1933	7,723,703	769,867	183,302	18,270,672	730,827	8,637,832	10,425,171	1.66

[a] Data compiled from Water Supply Paper 579, Power Capacity and Production in the United States, U. S. Geological Survey, 1928, and from the annual mimeographed reports on "Monthly and Annual Production of Electricity for Public Use in the United States" in 1927, 1928, 1929, 1930, and 1931.

In the domestic field the use of electricity has grown rapidly since 1917. The introduction of electricity into the home occurred in 1882 and showed a moderate growth to 1917 when 24 per cent of homes were supplied with electricity. The decade following 1917 witnessed a more rapid growth, the number of electrified homes increasing from 24 per cent of the total in 1917 to 63 per cent in 1927. By 1929, 70 per cent of the total number of homes were electrified, and it is estimated that 10 per cent more are within reach of transmission lines.

The rapid growth of the past decade cannot be expected to continue. In 1930, 1931, and 1932 a recession of electric power output occurred from the high level of 1929, amounting to 2 per cent in 1930, 7 per cent in 1931 and 16 per cent in 1932. The recession continued into 1932 until the middle of the year when reviving industrial activity reversed the trend. This decrease, the direct result of the severe industrial depression, is remarkably small when compared with the decline of production in manufacturing and transportation. The staying power of the electric power industry is accounted for partly by an increasing domestic load in spite of depressed industrial conditions. The expected gradual return of industrial production will eventually bring the electric power output to its previous high levels and, as electric service is extended, may be expected to surpass the past records. A rate of expansion comparable to the 1920-29 decade is not to be anticipated, however. Rural extensions will be limited since most of the agricultural population is widely distributed and the potential market is too small to warrant an investment in distributing lines. Electrification of industry has been largely accomplished and further addition will be slow. In the domestic market, electrification of homes has reached a point that indicates a slower rate of expansion. The period is rapidly approaching when the growth of new business for household lighting will be limited to the annual increase in the number of families. An expansion of electric power consumption above this annual growth can be brought about only by an increase in the number of appliances used in the homes. To what extent this will offer an outlet for an expanding electric market cannot be determined.

SOURCES OF ELECTRIC UTILITY COAL

In Table 35 is given the origin of coal used by the electric utilities of the Illinois coal market area. This table discloses, first of all, the importance of local coal in the electric utility market. In Illinois, for example, 81 per cent of the coal used in the Chicago district, including Lake County, Indiana, and in other Illinois, is obtained from Illinois sources. In Iowa and Missouri more than half of the coal is obtained from the local fields west of Mississippi River, and practically all of the rest from the Eastern Interior fields of Illinois, Indiana, and Western Kentucky. The latter state, in particular, is an important contributor of coal to its immediate neighbors north and west. Appalachian coal becomes important only in the states comprising the Lake

TABLE 35.—SOURCES OF COAL USED BY ELECTRIC UTILITIES IN 1928, IN NET TONS [a]

Source of Coal	Illinois Chicago	Illinois other	Iowa	Missouri	Kansas	Nebraska	Wisconsin	Minnesota	North Dakota	South Dakota	Total
Appalachian Fields	46,129	.....	725	3,200	.....	.....	764,129	230,866	46,032	46,867	1,137,948
Illinois	3,315,291	1,645,059	195,516	313,244	.....	128,001	37,692	149,568	.....	31,986	5,856,357
Indiana	580	87,943	11,136	.....	.....	146	5,011	.....	.....	.....	104,816
Western Kentucky	454,248	571,304	202,502	85,849	.....	820	1,820	39,408	1,428	.....	1,357,379
Trans-Mississippi River States	.....	.....	465,040	798,145	298,944	335,469	.....	3,196	235,699	54,217	2,190,710
Total	3,816,248	2,304,306	874,919	1,200,438	298,944	464,436	848,652	423,038	283,159	133,070	10,647,210

[a] Sources of Coal and Types of Stokers and Burners used by electric public utility power plants: A report of the Institute of Economics in co-operation with the United States Geological Survey, by W. H. Young, pp. 75-77.

Dock Territory. This is particularly true of Wisconsin which obtains about 90 per cent of its coal from the Appalachian fields. This is explained, no doubt, by the fact that 80 per cent of the coal used by electric utilities in Wisconsin is consumed in counties bordering lakes Michigan and Superior. The proportion of Appalachian coal used by the electric utilities in Minnesota is not as high as Wisconsin, being about 55 per cent in 1928. Most of this is consumed in the Twin City and Duluth districts, both of which are closely connected with lake transportation.

OTHER FACTORS AFFECTING THE SOURCE OF ELECTRIC UTILITY COAL

The demand for coal by electric utilities is widely scattered, yet the bulk of it is concentrated in the largest centers of population and industry. In the Illinois coal market area, the following factors must be given consideration in the present and future distribution of demand:

(1) Location of water power resources.
(2) Effect of fuel oil and gas competition.
(3) Availability of adequate condensing water.
(4) Location of power consuming centers.

Power consuming centers or districts which consumed approximately 70 per cent of the coal used by electric utilities in the Illinois coal market area in 1929, in the order of their importance were as follows:

Chicago district; Lake, Cook, Will counties and Lake County, Indiana	4,261,310
St. Louis district; Madison and St. Clair counties, Illinois, and St. Louis County, Missouri	1,147,888
Eastern Wisconsin; Racine, Milwaukee, Ozaukee, Sheboygan, Manitowoc, Brown, Fond du Lac, and Washington counties	782,459
Kansas City–St. Joseph district; Jackson and Buchanan counties, Missouri, and Wyandotte County, Kansas	711,934
Peoria; Peoria and Tazewell counties	558,859
Twin Cities district; Hennepin and Ramsey counties	518,697
Southern Wisconsin-northern Illinois district; Winnebago County, Illinois; Rock and Dane counties, Wisconsin	185,560
Rock Island County	114,277
Total	8,280,984
Total in the Illinois coal market area	11,631,406

In each instance, except southern Wisconsin, the power plants supplying these markets are located near large available supplies of condensing water. The importance of this factor arises out of the fact that from 400 to 700 tons of cooling water for each ton of coal consumed is necessary for the economical operation of a power plant. This has stimulated the concentration of power plants in locations where water in unlimited quantities is available. Since the survey of coal consumption in 1929, additional water front stations are being erected in Ozaukee and Sheboygan counties, Wisconsin, which

further increases the localization of power plants on Lake Michigan. The low cost of coal transportation from the Appalachian fields over the Great Lakes to Wisconsin lake ports provides an added stimulus to the concentration of power sites along the western side of Lake Michigan. The combined factors of available water supply and cheap transportation will serve to continue the trend toward fewer and larger stations, the erection of transmission lines and the elimination of isolated interior stations.

CHAPTER VII

CONSUMPTION OF COAL IN THE MANUFACTURING INDUSTRIES

USE OF COAL IN THE MANUFACTURING INDUSTRIES

Coal is used in manufacturing in three different ways, namely: (1) to generate power by means of steam engines; (2) to produce heat that is applied directly to materials to transform them or to facilitate their manipulation; (3) to furnish material that enters into the actual composition of the product. The important industries using fuel in the latter manner are coke and gas.

Consumption of coal in the manufacturing industries increased with the expansion of industry until 1923, after which it declined, although industrial activity continued to increase thereafter until 1929. The trend of industrial activity by selected years from 1909 to 1929 is shown in Table 36.

TABLE 36.—GROWTH OF MANUFACTURING AND COAL CONSUMPTION, 1909–1929[a].

Year	Average number of wage earners, in thousands	Primary horsepower, in thousands	Value added by manufacture, in millions of dollars	Net tons of coal used, in thousands
1909	6,615	18,675	$ 8,529	177,853
1914	7,036	22,437	9,878	182,315
1919	9,096	29,505	25,042	219,518
1921	6,944	.....	18,327	.....
1923	8,777	33,094	25,846	241,156
1925	8,382	35,767	26,771	.....
1927	8,350	38,826	27,585	261,442
1929	8,838	42,931	31,885	224,419

[a] Data from Department of Commerce, Bureau of the Census.

CAUSES OF DECLINE IN THE USE OF COAL

The causes of the decline of coal consumption in the face of increasing output in manufacturing industries are to be found in (1) the transfer of the power load to the electric utilities through the use of purchased power, (2) increased use of privately generated electric power in place of mechanical power, (3) improved practices in private steam plant operation, (4) saving of by-product heat, and (5) competition of fuel oil and natural gas.

TABLE 37.—CONSUMPTION OF FUELS BY THE MANUFACTURING INDUSTRIES IN THE ILLINOIS COAL MARKET AREA [a]
(In thousands of net tons)

Type of Fuel	Year	Illinois	Wisconsin	Minnesota	Iowa	Missouri	North Dakota	South Dakota	Nebraska	Kansas	Total	Percent of total bit. coal
Anthracite	1929	395	253	93	27	79	2	6	4	36	895	.....
	1919	266	117	46	17	16	2	3	3	7	477	.....
Bituminous	1929	19,919	5,541	2,873	2,366	3,243	231	126	690	600	35,589	.....
	1919	16,503	5,272	2,484	2,134	4,118	192	97	918	1,403	33,121	.....
Coke	1929	5,019	272	465	103	157	2	5	100	31	6,154	.....
	1919	3,903	543	440	135	194	1	9	57	61	5,343	.....
Fuel Oil[b]	1929	2,680	390	182	177	620	4	14	129	735	4,931	.....
	1919	1,170	143	70	137	440	.....	17	103	765	2,845	.....
Gas[b]	1929	1,053	160	288	7	210	1	13	2	452	3,186	.....
	1919	71	26	29	4	33	.....	1	1	521	686	.....
Total	1929	24,047	6,596	3,901	2,680	4,309	240	164	925	1,854	50,755	70
	1919	18,010	6,101	3,069	2,407	4,801	195	127	1,083	2,757	42,472	78

[a] Census of Manufacture, 1929, Consumption of Fuel and Electrical Energy in Manufacturing Industries, pp. 13, 14.
[b] Fuel oil converted into equivalent of net tons of coal on a basis of 175 gallons of fuel oil to a ton of coal; manufactured gas on a basis of 50,000 cubic feet to a ton of coal; natural gas on a basis of 25,000 cubic feet to a ton of coal.

Electrification of manufacturing industries has made rapid progress in the past, increasing from 11 percent of the primary horsepower used in manufacturing in 1905 to 61 percent in 1927. Both privately developed power and purchased energy have increased at the expense of mechanical power—the latter more rapidly. Coal consumption in the manufacturing industries, therefore, has been curtailed in part by the transfer of energy demand to the electric utilities and in part by increased economy in coal use by conversion from mechanical power to electrical power within the plant itself. It is probable that the production of electricity in electric utility plants is accomplished with much greater fuel economy than in the case of electricity produced privately. Hence the transfer from the private generation of power, either mechanical or electrical, to the electric utility means not merely a transfer of coal consumption from one group of industries to another but an actual loss in the coal market; how much, it is difficult to say. Moreover, it may also mean a substitution of water power for coal power to a certain extent. Motors run by purchased power increased over 100 percent from 1919 to 1927, while steam power and internal combustion engines showed a loss.

The rapid rise of the rated horsepower of motors using purchased power must not be taken as an indication that either purchased power or total power consumption has risen in the same proportion. In many factories some of the motors are idle or are operating at considerably less than their rated capacity during a large part of the time, so that the combined rated capacity of all the motors greatly exceeds the amount of power delivered by them at any given moment.

The shifting trends of fuel consumption in the decade of 1919-1929 in manufacturing industries of the Illinois coal market area is shown in Table 35. Fuel oil and gas are converted to coal equivalent on a basis of 175 gallons of fuel oil per ton of coal and 25,000 cubic feet of natural gas to a ton of coal and 50,000 cubic feet of manufactured gas for the same. In this table coke is excluded from the Illinois total in view of the fact that this is a product derived from coal used in coke ovens, and, if included, would result in double counting.[1] Strictly speaking, this should also apply to manufactured gas which is a by-product of coke manufacture, but, in this case we are dealing with a fuel which in 1919 was largely wasted but by 1929 was being recovered and is therefore an addition to the total fuel supply.

An analysis of Table 37 showing consumption of fuels in manufacturing industries in two representative years, 1919 and 1929, discloses certain trends and developments that have vitally affected consumption of coal. In 1919 coal represented 78 per cent of fuel used by the manufacturing industries; a decade later, its position had fallen to 70 per cent, although the absolute

[1] Total exclusive of coke is not entirely justified since small quantities estimated at 250 thousand tons find their way into this market from Appalachian and Colorado ovens, and 1,800 tons come from Indiana, mostly to the Chicago district.

quantity had increased. During that interval, the use of fuel oil had almost doubled in quantity and gas (both natural and manufactured) increased from almost negligible quantities to 6 per cent of the total. This period of our industrial history was marked by a rapid expansion in petroleum output accompanied by an excessive output of fuel oil, the discovery and development of prolific gas producing fields in the Mid-Continent area, and rapid development in by-product coke manufacture and the recovery of by-product gases. Moreover, the end of the war period also marked the high level of coal prices, one of the most important factors in stimulating the search for and use of substitute fuels. Fuel competition was further intensified by remarkable advances in fuel economy. The effect has been, in the manufacturing industries, as among energy consumer groups, to flatten the curve of fuel demand in spite of an increasing industrial output and in the face of an increase in the availability of energy supplies.

FUEL OIL

Fuel oil made its most rapid advance in the early part of this decade reaching a point of stabilization about 1926. The bulk of fuel oil is used for industrial heating or power purposes for which coal could be substituted. Much of its represents the endeavor to extend the market for fuel oil at low prices in competition with coal and would decline greatly in the event of a shortage in fuel oil supply.

NATURAL GAS

Natural gas is important only in Kansas. The extension of long distance pipe lines to Chicago, St. Louis, Omaha and adjacent cities has affected mainly the consumption of other fuels in domestic heating and cooking, in the public utilities and in small manufacturing establishments. The high cost of gas transported several hundred miles from the field of origin will probably preclude its entry into the general manufacturing market.

MANUFACTURED GAS

The rise in manufactured gas is attributable to the improved methods of recovering, purifying, and utilizing what were formerly waste by-product gases, permitting the transfer of greatly increased quantities of gas from coke ovens and blast furnaces to steel works and rolling mills and to other steel-fabricating plants. Also part of the increase in 1929 is due to the inclusion of data for gases produced and consumed in the same plants, or in plants under the same ownership.

SUMMARY

It is probable that the greatest changes in the shifting competitive relationships of the fuels used in manufacturing have been accomplished in

the decade just closed. The determined efforts of the petroleum industry to hold production and refining within the limits of demand will bring about with it a stabilization or gradual decline in fuel oil supply. Higher prices for this fuel will result in a reversion to coal among the units of the manufacturing group. Cheap natural gas is limited to the areas of production and will be a factor only in the manufacturing industries of the Mid-Continent field where industrial activity is of secondary importance. Progress in by-product gas recovery has reached a point where further improvement will not materially increase the quantity of gas.

The trend in fuel consumption by the manufacturing group is not likely to rise above the 1929 level for some time in the future. The severe reverses of 1930, 1931, and 1932 reduced fuel consumption to a point where a substantial increase in output is necessary before a recovery equal to the 1929 market can occur.

CHAPTER VIII

RAILWAY FUEL CONSUMPTION

IMPORTANCE OF COAL IN RAILWAY TRANSPORTATION

The extent of railway mileage in the United States and the higher ratio of car miles to number of cars loaded as compared with other industrial nations results in an unusually large consumption of coal by American railroads. In 1929, for example, coal consumption by Class I railroads of the United States was 112,951,000 tons, plus fuel oil equivalent to 14,550,000 tons of coal while railroads of the United Kingdom consumed 14,900,000 tons of coal, and the German railroads, 16,600,000 tons.

The trend of railway coal consumption since 1917 has been downward. Several factors such as the use of fuel oil, increased efficiency of fuel utilization, variations in industrial activity and gradual changes in mode of transportation have affected this downward trend. In Table 39 is given the quantity of coal and the fuel oil equivalent of coal purchased by Class I Railroads from 1917 to 1932, together with data on the quantity of bituminous coal loaded for shipment and the ratio of railway fuel used to coal loaded for shipment.

The competitive effect of fuel oil is shown in the progressive increase in percentage of total fuel used by railroads.

DOWNWARD TREND OF RAILWAY FUEL CONSUMPTION

The progressive decline of fuel consumption by railroads, as shown in column (3) is a direct result of increasing efficiency of railway operation. Statistics of fuel consumption per 1,000 gross ton-miles, including locomotive and tender, are available back to 1920. In that year the average consumption was 173 pounds. Each succeeding year, except 1922, has shown improvement, the average for 1929 being 125 pounds. A similar record is to be observed in the passenger service. Fuel required to move a passenger car one mile in 1929 was 16.7 pounds whereas in 1923, the first year for which the figures are available, it was 20.7 pounds. Further economies were effected in the ensuing years, but the sharp decline in total fuel consumption from 1929 to 1932 was primarily the result of decreased railway traffic.

Decrease in fuel consumption was felt more severely by coal than by fuel oil. In fact the latter increased substantially to 1924 after which it remained

relatively stationary and showed a decline only after 1930. Even then the decline was relatively less than coal as shown by the increasing percentage of total fuel consumption in column (4) of Table 39.

Consumption of railway fuel also shows a close relationship to activity in the coal industry itself. Column (6) in Table 39 shows the relationship between fuel consumption by railroads and revenue coal loaded for shipment at the mines. Since 1926 the percentage has been fairly constant so that a large part of the decreasing consumption of railway fuel is directly attributable to a curtailed demand for coal.

Future trends in coal consumption by railroads must take into account:

(1) Factors affecting the future of railroad traffic.
(2) Future trend of fuel oil use.
(3) Future of railroad electrification.
(4) Trends in fuel efficiency.

Increase of railroad freight traffic has been proportionately less than the increase in commercial and industrial activity of the nation.

The explanation lies partly in the greater use of highways, gas, crude oil and gasoline pipe lines and inland waterways for the transportation of freight. Also, relocation of industries to get nearer to sources of raw materials or centers of consumption, or both, in order to save transportation expense, tends to diminish railway traffic. Increasing use of private automobiles and motor buses have made serious inroads on passenger traffic.

USE OF FUEL OIL

Ninety-five per cent of fuel oil consumed by railroads in the United States is delivered to railroads operating in two areas, the group of southern states, extending from Louisiana to California, and the group of northwestern states from Montana and Wyoming to the Pacific Coast. Since commercial deposits of coal are not readily accessible to railroads in the West, South Central, and Pacific states, except by a long freight haul, while ample supplies of fuel oil are available in the vicinity of the railroads, lines operating in these areas will continue to use fuel oil.

RAILROAD ELECTRIFICATION

With the exception of the electrification program of the large railroad terminals, and some of the short heavy traffic lines, no extensive new construction of this type is anticipated. Present consumption of electrical energy, together with the increase resulting from electrification projects now under construction, will effect only minor reductions in the annual coal bill.

TABLE 38.—FUEL COAL DELIVERED TO CLASS I RAILROADS BY CONSUMING REGIONS IN 1929[a]

Region	Total coal delivered	Illinois deliveries
New England	4,098,802	.....
Great Lakes	25,093,486	2,595,492
Central Eastern	33,167,794	1,820,332
Pocahontas	6,414,000	.....
Southern	20,408,906	3,276,002
Northwestern	16,238,843	4,576,962
Central Western	16,307,336	5,615,984
Southwestern	5,593,408	2,025,903
Total	127,322,665	19,910,681

[a] Distribution of coal shipments, U. S. Bureau of Mines, Monthly Coal Distribution Report No. 8, March, 1932, p. 8.

TABLE 39.—FUEL USED BY CLASS I RAILROADS.

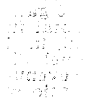
Year	(1) M	(2) M	(3) M	(4) Per cent	(5) Bituminous M	(6) Per cent
1917	131,714	10,700	149,414	7.2	469,851	31.8
1918	137,830	9,770	147,600	6.6	503,089	29.4
1919	122,674	9,440	132,114	7.2	409,149	32.2
1920	131,553	11,500	143,053	8.0	504,873	28.3
1921	110,554	9,900	120,454	8.2	382,064	31.4
1922	115,636	10,850	126,486	8.6	383,677	32.9
1923	134,106	13,850	147,956	9.4	505,859	29.2
1924	119,926	14,700	134,626	10.9	441,566	30.5
1925	119,888	14,600	134,488	10.9	477,173	28.2
1926	124,828	14,650	139,478	10.5	526,286	26.5
1927	117,486	14,450	131,936	10.9	480,223	27.4
1928	113,882	14,850	128,732	11.5	467,348	27.5
1929	121,951	14,550	127,501	11.4	497,934	25.6
1930	97,857	14,502	112,359	12.9	437,399	25.7
1931	81,213	12,410	93,623	13.2	357,278	26.2
1932	66,193	10,880	77,073	14.0	285,000	27.0

Column 1. Coal consumed by Class I Railroads of the United States, in thousands of net tons.
2. Coal equivalent of fuel oil consumed by Class I Railroads, in thousands of net tons. Fuel oil consumed is converted into equivalent coal fuel at a rate of 170 gallons of fuel oil to a ton of coal.
3. Total fuel consumption by Class I railroads of coal and coal equivalent of fuel oil, in thousand of net tons.
4. Fuel oil per cent of total fuel consumption.
5. Revenue coal loaded for shipment at the mines, in thousands of net tons.
6. Ratio of fuel used by railroads to revenue coal loaded for shipment at the mines.

TRENDS IN FUEL EFFICIENCY

Comparison of average performance with the best individual locomotive records indicates that progress in fuel economy made by railroads during the past decade has by no means reached its ultimate goal. Fuel efficiency is not merely a matter of increasing the thermal efficiency of the locomotive; it involves the management of operation of the railroad itself. Greater economy is obtained by supervision of engine maintenance, building train loads up to engine capacity, reducing idle engine time, treating boiler water to prevent scale, increasing tender capacity to reduce the number of coaling and water stops, and increasing the length of engine run. While this program of operating economy is running its course and the new level of efficiency is established, a stationary or even declining railroad coal market may be expected.

The Illinois coal industry has suffered a severe decline in coal deliveries to railroads. Data for 1917 and 1929 are available showing deliveries of coal to railroads by fields, indicating a drop in sales of Illinois coal from 33,696,513 tons in 1917 to 19,910,681 tons in 1929. Distribution of Illinois coal to the several railroad regions for that year is given in Table 38, p. 95.



CHAPTER IX

CONSUMPTION OF COAL IN THE DOMESTIC AND MISCELLANEOUS MARKETS[1]

Consumption of coal for domestic and commercial heating is the least known and most difficult to estimate among the several groups of coal consumers. By a process of elimination, a figure can be obtained for the consumption of coal in domestic heating and among the large number of small commercial and industrial consumers whose fuel requirements and purchasing habits do not differ markedly from those of the domestic user. A further deduction on the approximate consumption of domestic fuel can be obtained by estimates, based on data for single states or for specified years, of the per capita consumption of fuel for domestic use. Fortunately, accurate data of consumption, by states, of competitive fuels is available for coke in 1929, for fuel oil for the years 1926 to 1931, for anthracite in 1929, for fuel briquets in 1929-32 and for natural gas from the beginning of its use. With these figures as a basis, it is possible to evaluate, within a reasonable degree of accuracy, the relative position of bituminous coal in the total domestic energy market, and the trends in fuel consumption that are affecting this market.

CONSUMPTION OF ALL FUELS FOR DOMESTIC PURPOSES

In Table 40 is given the consumption of all fuels used for domestic purposes in 1929, the data for coal being estimated on a basis of 1.6 tons of fuel per capita per year.

Basis of calculations.—The quantity of bituminous coal used for domestic purposes in 1929 is obtained by multiplying the population of the area by 1.6—the calculated per capita consumption of coal or its equivalent in other fuels—and subtracting from this total the quantity represented by competitive fuels.

The results are shown in column (1) of Table 40. Two previous estimates of domestic fuel consumption are used as a basis of this calculation. In 1928, Tryon calculated the consumption of domestic fuel as 163,000,000 tons of which 136,000,000 tons was solid fuel and the equivalent of 27,000,000 tons

1 Includes heating large buildings other than factories, such as hotels, apartments, stores, offices, theatres, garages and service stations; also a number of other items that cannot be separated, such as waterworks, construction industry, threshing, public institutions, central heating plants, laundries, and very small industrial consumers not covered in the Census for Manufactures.

TABLE 40.—CONSUMPTION OF FUEL FOR DOMESTIC AND COMMERCIAL HEATING IN THE ILLINOIS COAL MARKET AREA, 1929 [a]
(Exclusive of wood)

State	(1) Bituminous coal, net tons (estimated)	(2) Anthracite, net tons[b]	(3) Coke, net tons	(4) Fuel briquets, net tons[c]	(5) Fuel oil, Barrels	(6) Fuel oil in equivalent tons of coal[d]	(7) Natural gas—M cubic feet	(8) Natural gas in equivalent tons of coal	(9) Total fuels in terms of coal equivalent	(10) Population 1930
Illinois	9,402,786	1,008,533	1,026,575	13,246	3,129,253	745,000	94,000	3,760	12,300,000	7,630,654
Wisconsin	3,060,271	941,422	407,636	120,171	705,828	170,500	.....	.....	4,700,000	2,939,006
Minnesota	2,802,496	465,312	403,467	297,775	576,000	137,000	.....	.....	4,100,000	2,563,953
Iowa	3,718,542	100,381	63,820	40,857	153,081	36,400	.....	.....	3,960,000	2,470,939
Missouri	5,090,344	18,494	155,222	6,940	1,013,762	240,000	7,224,000	289,000	5,800,000	3,629,367
North Dakota	914,502	56,933	4,636	98,129	66,297	15,800	.....	.....	1,090,000	680,845
South Dakota	909,507	77,449	6,627	68,367	34,732	8,250	870,000	34,800	1,105,000	692,849
Nebraska	2,090,019	35,386	7,777	27,818	164,046	39,000	.....	.....	2,200,000	1,377,963
Kansas	2,305,670	2,036	2,970	20,074	198,519	47,250	15,539,000	622,000	3,000,000	1,880,999
Total	30,294,187	2,705,946	2,078,730	687,377	6,041,518	1,439,200	23,727,000	949,560	38,255,000	23,866,575

[a] Data from U. S. Bureau of Mines.
[b] From April 1, 1928, to March 31, 1929.
[c] 1930 figures.
[d] Converted on a basis of 4.2 barrels of fuel oil as equivalent to one ton of coal.

was represented by gaseous or liquid fuels[2]. This is an average of 1.36 tons of coal per capita for the United States. However, climatic differences must be taken into account in calculating fuel consumption in the different geographic regions of the United States. For example, in the states comprising the Illinois coal market area, a consumption of 32,328,199 tons of coal, both anthracite and bituminous is reported in 1917[3], or an average of 1.58 tons per capita. This figure probably represents all but a negligible part of the total fuel consumption during this year in view of the fact that fuel oil for domestic purposes was hardly more than an incidental factor, natural gas amounted to the equivalent of about 300,000 tons of coal in the Illinois coal market area, and coke consumption also was small, certainly not exceeding 400,000 tons in this area.

TREND OF COMPETITIVE FUELS

Fuel Oil.—The use of fuel oil in domestic furnaces is an important one and is still showing a substantial increase. Fuel oil is a by-product of the gasoline manufacturing industry and as such, the available supply is governed by conditions which have no direct relation to an elastic demand. Increasing demand for gasoline was accompanied by increasing quantities of fuel oil for which a market had to be found. These markets fell mainly into the following groups:

Oil company use
Marine use
Oil-burning railroad locomotives
Public utilities—gas and electric
Manufacturing industries
Commercial and domestic heating

In each of these groups, coal was the established fuel and replacement by fuel oil could be made mainly on a basis of competitive cost. Occasionally, liquid fuels offered advantages which warranted a price above the level of a comparable quantity of coal but, in the main, the price tended to adjust itself to the competitive level. Moreover, the supply of fuel oil increased each year to such an extent that the sellers of fuel oil were constantly confronted with the problem of extending their markets, so that substantial price increases at any time were out of the question.

Prices of domestic fuel oils followed in general the trend of wholesale and industrial fuel oil prices so that, in spite of a fairly wide spread for retailers' margins and local distribution costs, the retail price of domestic burning oil was low enough to compete successfully with coal.

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2 Tryon, F. G., and Bennit, H. L., Coke and by-products: U. S. Bureau of Mines, Mineral Resources of the United States, 1928, Part II. Non-metals, p. 754.

3 Lesher, C. E., Coal—Part B, Distribution and Consumption; U. S. Bureau of Mines, Mineral Resources of the United States, 1917, Pt. II.

It must not be inferred that the encroachment of fuel oil in the domestic fuel market was due entirely to a competitive price level. In fact, the annual cost of heating a home is frequently higher with oil than with bituminous coal. The agressiveness of oil-burner salesmen, the appeal to convenience, and arguments of alleged greater cleanliness of fuel oil over coal were important factors in stimulating oil-furnace installations. The net result is that oil for domestic heating increased. The rate of growth for the Illinois coal market area is not available previous to 1926 but the general rate of growth for the country is shown in Table 41.

TABLE 41.—OIL CONSUMPTION FOR DOMESTIC HEATING[a]

Year	Barrels
1923 (heating season)	2,818,000
1924 (heating season)	5,021,000
1925 (heating season)	8,829,000
1926 (calendar year)	9,080,000
1927 (calendar year)	11,709,000
1928 (calendar year)	14,271,000
1929 (calendar year)	19,581,000
1930 (calendar year)	25,359,000
1931 (calendar year)	24,659,139
1932 (calendar year)	29,263,253[b]

[a] National Survey of Fuel Oil Distribution, 1930; U. S. Bureau of Mines, 1931, p. 19.
[b] U. S. Bureau of Mines, Mineral Market Report No. 252, Jan. 9, 1934.

FUEL OIL CONSUMPTION IN THE ILLINOIS COAL MARKET AREA FOR DOMESTIC AND COMMERCIAL HEATING, 1926-1931

The rapid growth of fuel oil heating in the Illinois coal market area is shown in Table 42, giving consumption in commercial and domestic heating. This does not include light furnace oils for which statistics by states are not available. The most rapid growth is shown in the domestic group where the increase from 1926 to 1930 is at a ratio of 1:3.2. An examination, by states, shows that the most rapid growth occurred in the states of Illinois, Wisconsin, Minnesota, and Iowa. Those states are practically removed from the area of large scale competition from natural gas; also this is the area of high priced domestic coal so that it offered the most favorable territory for fuel oil originating at the refineries of the Chicago district. The increase in Wisconsin and Minnesota is particularly noticeable.

The question of immediate interest to the coal industry is the probable future trend of domestic consumption. The expansion of natural gas lines in eastern Kansas and Nebraska and western Missouri and Iowa may limit the further expansion of both fuel oil and coal in this part of the market area. Gas pipe lines to Chicago will replace a part of the domestic fuel oil and coal market in this city. The principal battle ground will be in the high-cost domestic fuel areas of the northern group of states. The competitive position of oil, bituminous coal, and anthracite will be determined by the factors

TABLE 42.—FUEL OIL CONSUMED FOR DOMESTIC AND COMMERCIAL HEATING IN THE ILLINOIS COAL MARKET AREA, 1926-1931 [a]

(In barrels of 42 gallons each)

	1926	1927	1928	1929	1930	1931
Commercial Heating						
Illinois	779,073	1,105,040	1,398,296	1,336,604	1,230,549	1,117,996
Wisconsin	98,558	203,182	275,595	289,044	301,972	204,049
Minnesota	198,251	463,385	321,390	285,360	381,665	474,971
Iowa	24,852	20,720	69,032	59,527	76,569	65,028
Missouri	642,915	660,066	755,129	715,928	873,185	764,497
North Dakota	16,518	18,244	19,892	26,478	41,114	47,599
South Dakota	11,136	18,665	22,211	30,580	37,675	46,958
Nebraska	23,332	56,000	39,850	49,032	103,908	110,716
Kansas	242,651	116,159	227,794	161,418	80,406	53,932
Total	2,037,286	2,656,461	3,129,189	2,953,971	3,127,043	2,885,746
Domestic Heating						
Illinois	650,075	1,151,069	1,567,725	1,792,649	1,870,439	1,716,692
Wisconsin	76,694	159,192	187,986	416,784	499,045	428,020
Minnesota	12,930	299,583	277,267	290,640	388,950	497,983
Iowa	20,874	79,382	66,167	93,554	244,783	239,532
Missouri	294,399	340,425	257,987	297,834	542,014	553,996
North Dakota	.....	.....	3,424	39,819	42,514	31,684
South Dakota	452	4,575	4,303	4,152	5,514	23,368
Nebraska	116,601	110,516	109,616	115,014	228,517	141,148
Kansas	24,482	23,962	19,214	37,101	29,137	29,788
Total	1,196,507	2,168,704	2,493,689	3,086,547	3,850,913	3,662,211
Total						
Illinois	1,429,148	2,256,109	2,966,021	3,129,253	3,100,988	2,834,688
Wisconsin	175,252	362,374	463,581	705,828	801,017	632,069
Minnesota	211,181	762,968	598,657	576,000	770,615	972,954
Iowa	45,726	100,102	135,109	153,081	321,352	304,560
Missouri	937,314	1,000,491	1,013,116	1,013,762	1,415,199	1,318,493
North Dakota	16,518	18,244	23,316	66,297	83,628	79,283
South Dakota	11,588	23,240	26,514	34,732	43,189	70,326
Nebraska	139,933	166,516	149,466	164,046	332,425	251,864
Kansas	267,133	140,121	247,008	198,519	109,543	83,720
Total	3,233,793	4,830,165	5,622,878	5,041,518	6,977,956	6,547,957

[a] Data from annual "National Survey of Fuel Oil Distribution", a report of the U. S. Bureau of Mines and published by the American Petroleum Institute.

of price, convenience, cleanliness, and marketing practices. The average price of various types of fuel in Chicago in 1932 where the competitive battle among the fuels is particularly keen was as follows:

Coal (per ton)	Price	
Anthracite		
Stove	$16.73	
Chestnut	15.30	
Bituminous		
High volatile	7.72	
Low volatile	11.41	
Run of mine	7.48	
Fuel oil (per gallon)	.06	
Natural gas (per therm)	.07	(after the first 26 therms)

The existing price relationships are not likely to be permanent or even of long duration. Bituminous coal prices can be fairly assumed to show no substantial increase in the future under existing competitive conditions among coal producing fields and districts. The present low price of fuel oil is by no means assured. In spite of the present large flowable potential represented by such fields as East Texas, Kettleman Hills (Middle Dome), Oklahoma City and Yates Pool, the combined effect of curtailment efforts on the part of the oil industry and the absence of major discoveries since 1930 point to an approaching scarcity and higher price for crude oil with its accompanying effect on fuel oil prices also.

Higher prices of fuel will not necessarily result in a return to coal burning equipment. Further improvements in oil-burning equipment and lower costs of domestic installations would favor continuance of this demand, although a decline in fuel oil supply might limit its further expansion. Moreover, the development of automatic domestic furnaces using prepared sizes of bituminous coal is giving these fuels more of the convenience factor.

The aggressive activities of oil burner salesmen, also, has been a factor in increased oil installations, a factor which coal dealers have ignored too long.

TRENDS IN NATURAL GAS CONSUMPTION

The sudden expansion of natural gas production and consumption in the Mid-Continent area and its distribution through long distance pipe lines to Chicago, Indianapolis, St. Louis, western and northern Iowa, eastern Nebraska, and western Missouri constitutes one of the most dynamic events in disturbing the markets of the older established fuels, both coal and fuel oil. The use of gas within or near the areas of production has long been established; long distance transportation began only with the discovery of huge reserves with prospects of long duration (notably the Hugoton fields in Kansas, the Amarillo field in north Texas, and the Monroe field in Louisiana) and a supply far in excess of the fullest possible market requirements of the Mid-Continent area itself. The effect upon the coal industry is disturbing

because the extent of its competition and the future trend is still largely an unknown factor. The general effect of natural gas invasion has been discussed in Chapter IV and the present analysis will be confined to the domestic fuel market.

Natural gas pipe lines now enter the Illinois coal market area through four major pipe line systems, namely, from the Texas Panhandle to Chicago; from the Hugoton Field in Kansas to Indianapolis with outlets to Springfield, Peoria, Clinton, Urbana, Danville, Decatur, and in central Missouri communities; from the Monroe field in Louisiana to St. Louis and Alton; and from the Texas Panhandle to a belt of communities in eastern Nebraska and central Iowa. A local field in eastern Montana serves the western Dakotas.

Domestic consumption of natural gas has shown a slow growth from 1920 to 1931 in this area as shown in Table 24, and averages 17,672,000,000 cubic feet, an equivalent of about 700,000 tons of coal. An examination of consumption by states, however, shows that the displacement of domestic coal by long distance pipe line gas is significant. Half of the domestic gas consumption is in Kansas which has long been supplied by local fields. The stationary behavior of consumption in this state indicates that the point of saturation of this fuel has been reached.

Previous to 1928, domestic gas consumption in Illinois depended largely on local gas supplies and, consequently, was declining. The introduction of gas through long distance pipe lines reversed the trend so that after 1929 there was a rapid increase in consumption. Outside of these three states, the most significant increase has been in western South Dakota which obtains its gas from Montana. Nebraska used gas for the first time in 1930 and the extent of this market is still problematical.

The place that natural gas will occupy in the domestic fuel market rests upon the factors of price, cleanliness and convenience, and the limitations imposed by the physical problems of distribution. The price of natural gas for domestic distribution must necessarily be high because of the nature of the market. First an elaborate distribution system is necessary involving a high overhead cost per unit of gas used, together with a relatively high clerical cost for handling the large number of small accounts. Secondly, the extreme seasonality of the household load imposes a burden of idle equipment upon the gas distribution company in the summer. These costs must necessarily be carried by the consumer, if the market is to be profitable to the gas distributors. Gas rates for residential service in Chicago, for example, are:

Therms[a] used in any one month	Charge	Cost of coal per ton at equivalent rates per therm
For the first 2 therms	58.0 cents	$162.40
For the next 24 therms	15.8 cents	44.24
For all over 26 therms	7.0 cents	19.60

[a]A therm is equivalent to 100,000 B. t. u's.

The second factor in limiting the extent of the domestic gas market is the physical limitation imposed by the distribution system. The rural dwelling is excluded by the prohibitive cost of gas transportation to a single dwelling. In urban communities, the nature of the gas load bears an important relation to the economic feasibility of gas utilization. If there is no industrial outlet to balance demand with the highly seasonal domestic load, the overall costs per unit of gas are higher and the price must be correspondingly high also. This in itself will impose limitations on the extension of gas into small urban communities in competition with coal or fuel oil.

Cleanliness and convenience are factors which would to a certain extent permit a higher price for gas and would have their greatest appeal to customers in the higher economic level.

ANTHRACITE IN ILLINOIS COAL MARKET AREA

The part occupied by anthracite in the Illinois coal market area can be analyzed briefly by an examination of Tables 43, 44, and 45. It is apparent that this type of fuel is losing ground in the area served by Illinois coal. Its original pre-eminent position is due to its excellence as a clean, smokeless fuel, coupled with a reasonably low pre-war cost. Moreover, consumer habits in Chicago, eastern Wisconsin, and the Twin Cities district in Minnesota, the principal anthracite consuming centers were strongly inured in the use of this fuel. Rising prices and the aggressiveness of competition, particularly fuel oil and coke, eventually served to weaken the hold of anthracite in this territory and it appears destined to recede to a negligible position. It will probably retain a considerable market in the lake shore counties of northern Illinois and eastern Wisconsin, and the northwest territory at the head of the Lake Superior docks, which can be reached by low lake freight rates. On the other hand, this market is practically closed to Illinois coal producers because of high all-rail freight rates from the southern fields to the lake shore territory. However, into interior Wisconsin and Minnesota, and in the states farther south and west, the costs of transportation on anthracite from lake ports mounts rapidly so that the competitive advantage of transportation in favor of eastern coals soon disappears.

FUEL BRIQUETS

Consumption of fuel briquets has shown a rapid increase in this country from 1924 to 1929 but their percentage of the total domestic fuel bill is so small that these increases are not significant. The record for the country as a whole since 1924 is shown in Table 46.

TABLE 43.—ANTHRACITE CONSUMPTION 1916–1917, 1921, AND 1928–1929
(Net tons)

State	1916–17[a]	1921[b]	1928–29[c]
Illinois	2,806,367	2,300,000	1,008,533
Wisconsin	1,545,490	1,498,000	941,422
Minnesota	1,327,050	850,000	465,312
Iowa	471,694	196,000	100,381
Missouri	198,542	102,000	18,494
North Dakota	283,259	108,000	56,933
South Dakota	240,298	108,000	77,449
Nebraska	177,825	60,000	35,386
Kansas	20,674	8,150	2,036
Total	7,071,199	5,230,150	2,705,946

[a] Lesher, C. E., Coal in 1917, Part B. Distribution and Consumption; U. S. Geological Survey, Mineral Resources of the United States, 1917, p. 1245.
[b] Report of the United States Coal Commission, Part II, Anthracite, p. 685, figures converted to net tons.
[c] Distribution of Coal Shipments; U. S. Bureau of Mines, Monthly Coal Distribution Report No. 12, July, 1932, p. 4.

TABLE 44.—SHIPMENT OF ANTHRACITE BY RAIL AND WATER IN 1929
(Net tons)

State	Total heating season	By water calendar year	By rail
Illinois	1,008,533	16,731	991,802
Wisconsin	941,422	688,882	252,540
Minnesota	465,312	459,783	5,529
Iowa	100,381	12,206	88,175
Missouri	18,494	.....	18,494
North Dakota	56,933	51,789	5,144
South Dakota	77,449	73,241	4,208
Nebraska	35,386	5,446	29,940
Kansas	2,036	.....	2,036
Total	2,705,946	1,308,078	1,397,868

TABLE 45.—COMPARATIVE PRICES OF ANTHRACITE AND BITUMINOUS COAL IN THE CHICAGO DISTRICT, JULY 15, 1917, 1929, 1932

Year	Anthracite		Bituminous		
	Stove	Chestnut	High vol.	Low vol.	Run-of-mine
1917	$9.57	$9.67	.....	$6.81	.....
1929	16.55	16.10	$7.74	10.35	$7.50
1932	15.50	15.05	7.53	8.97	6.95

TABLE 46.—CONSUMPTION OF FUEL BRIQUETS

Year	Tons consumed	Consumed in Illinois coal market areas	
			Per cent
1924	580,470	.....	.....
1925	839,370	.....	.....
1926	995,332	.....	.....
1927	970,468	.....	.....
1928	947,423	.....	.....
1929	1,212,415	.....	.....
1930	1,028,865	687,377	67
1931	688,258	433,308	63
1932	485,288	318,374	65
1933	529,162	340,765	64
1934	703,592	420,550	60

In the years 1930 to 1934, the Illinois coal market area accounted for about two-thirds of the total consumption and one-half of the total production. Other important producing and consuming centers are in Pennsylvania, Ohio, New Jersey, and Massachusetts. A list of plants operating in 1931 in the Illinois coal market area together with the type of raw material used and the location of the plant is given in Table 5 (p. 23).

Apparently briquetting plants and the briquet industry find their economic position in the areas of high priced domestic fuels and near sources of waste or by-product raw materials. In the lake dock coal trade, there is a considerable production of fines and screenings through degradation as a result of frequent handling.

This results in a degradation at the docks of from 5-6 per cent on the best grades of anthracite to 60 or even 70 per cent on the brittle Pocahontas.[5] These screenings are sold to different consumers, the price averaging from $5.50 to $6.00 a ton delivered.

The average selling price of briquets in the central states varies from $8.00 to $9.00 a ton. The largest item of expense in manufacture is raw material. An analysis of manufacturing costs per ton was compiled by the U. S. Bureau of Mines for 1927 at 16 briquetting plants resulting in the following figures:

Cost	Total	Per ton
Salaries	$ 149,598	$0.17
Wages	426,584	.47
Materials	4,609,988	5.09
Power and fuel used	236,411	.26
Total	5,422,581	5.99
Value of product	7,116,710	7.86
Value added by manufacture	1,694,129	1.87

5 Vaile, R. S., and Pickett, V. G., Coal Distribution in the Twin Cities; University of Minnesota, Studies in Economics and Business, No. 2, June, 1932, p. 39.

To the per ton cost of $5.99 must be added additional charges for insurance, taxes, interest on the investment, and depreciation of the equipment. The average costs quoted above are probably somewhat lower than in the Wisconsin plants because of a higher cost of raw material for the latter. The briquet operator must work on a narrow margin of profit. The retail value of his product is governed by competitive conditions and will tend to follow more or less the price of prepared sizes of bituminous coal. With better preparation and improved stokers for the latter fuel, the competitive position of briquets is likely to become more difficult.

TABLE 47.—CONSUMPTION OF FUEL BRIQUETS IN THE ILLINOIS COAL MARKET AREA, 1930 to 1934

(In net tons)

State	1930	1931	1932	1933	1934
Illinois	13,246	7,918	5,474	6,218	12,606
Wisconsin	120,171	77,907	65,872	89,131	104,885
Minnesota	291,775	200,583	137,292	133,102	168,067
Iowa	40,857	23,843	18,310	19,269	22,713
Missouri	6,940	4,271	3,005	4,360	5,904
North Dakota	98,129	52,288	43,915	46,746	50,525
South Dakota	68,367	39,490	29,999	28,704	34,401
Nebraska	27,818	16,975	8,245	8,992	16,171
Kansas	20,074	10,033	6,262	4,243	5,278
Total	687,377	433,308	318,374	340,765	420,550
Total U. S.	1,028,865	688,258	485,288	529,162	703,592
Per cent of total	67	63	65	64	60

COKE AS A DOMESTIC FUEL

The use of coke as a domestic fuel has grown consistently and has suffered less in the years of severe business depression, 1930-1932, than its older competitor—anthracite. Consumption in 1929, the year selected for detailed distribution data is shown in Table 48.

TABLE 48.—CONSUMPTION OF COKE FOR DOMESTIC PURPOSES.

State	*Tons*
Illinois	1,026,575
Wisconsin	407,636
Minnesota	403,467
Iowa	63,820
Missouri	153,222
North Dakota	4,636
South Dakota	6,627
Nebraska	7,777
Kansas	2,970
Total, Illinois coal market area	2,078,730
Per cent of U. S. total	30.2
Total, United States	6,826,694

The unusually high proportion of the nation's domestic coke consumption within the boundaries of the Illinois coal market area is probably the outcome of an effort to find an acceptable substitute for the high cost anthracite. A similar concentration of consumption is observable with fuel briquets indicating that a moderate priced prepared domestic fuel with characteristics approaching the clean, smokeless qualities of anthracite can find a ready market in this area.

COMPETITION AMONG BITUMINOUS COALS FROM APPALACHIAN AND ILLINOIS FIELDS

Illinois coal producers of domestic coal grade meet competition not only from gas, fuel oil, anthracite, coke, and briquets, but, to a large measure from the prepared sizes of eastern bituminous coals. Data on total shipments of eastern coal by all-rail haul and over the lake docks are available but the specific quantity used for domestic heating is not known. The extent to which eastern coals are used is a resultant of the factors of consumer habits or preferences, dealers' preferences, extent of wholesale coal distribution in the important coal receiving and coal distributing centers of this market area, and comparative delivered costs. In this last item transportation costs play an important part and an analysis of transportation from representative competing fields in Illinois and the eastern states makes it possible to delimit more sharply the areas in which each has the advantage and areas where competition is keen.

In Table 14 are given freight rates on coal from three competing areas,[6] viz., southern Illinois, the high volatile fields of the Kenova-Thacker district, and the low volatile fields of the Pocahontas and Tug River districts. The latter are favorably regarded as domestic fuels.

An analysis of this table shows that the freight rate structure favors eastern coals in the markets north of Chicago on the eastern Wisconsin shore and in the Duluth-Superior district. In Chicago and the St. Paul-Minneapolis district transportation rates are almost comparable with a slight advantage to southern Illinois coal. In the interior cities of northern Illinois, Wisconsin, and Minnesota, the added freight rate on eastern coal from the lake docks brings the total cost of transportation considerably above the all-rail rate to these same localities from the southern Illinois fields. The line of demarcation between the areas in which eastern coal is dominant and in which Illinois coal can find a profitable outlet may be drawn roughly to include the lake shore tier of counties into the former area.

The dominant position of lake cargo coal in the lake dock territory is explained by an examination of Table 49. Counties bordering the lake in

[6] The freight rate on coal carried over the lakes includes loading charge of $.08 at the lower lake docks. Lake rates are figured at 50 cents to Chicago and Milwaukee and 40 cents to Duluth-Superior.

TABLE 49.—BITUMINOUS COAL CONSUMPTION IN THE LAKE SHORE COUNTIES OF NORTHERN ILLINOIS, EASTERN WISCONSIN, AND NORTHEASTERN MINNESOTA, 1929

County	Coal used, in net tons				
	In manufacturing	In public utilities	In mines and quarries	Domestic fuel estimated at 1.6 tons per capita	Grand total
Illinois	10,108,910	3,729,647	53,467	6,537,000	
Cook	9,632,892	3,380,269	53,467	6,370,000	
Lake	476,018	349,378	.....	167,000	
Wisconsin	4,366,056	837,756	9,661	2,283,500	
Kenosha	131,565	.....	.....	101,000	
Racine	15,022	.....	4,528	144,000	
Milwaukee	2,955,748	644,894	1,738	1,160,000	
Waukesha	40,797	202	2,718	83,500	
Ozaukee	.....	957	10	27,800	
Washington	31,832	11,802	.....	42,400	
Sheboygan	147,901	31,199	.....	113,800	
Fond du lac	80,540	10,413	.....	95,500	
Manitowoc	162,850	34,803	.....	93,700	
Calumet	10,459	.....	.....	27,000	
Brown	159,322	38,116	304	112,200	
Kewanee	6,949	.....	.....	25,600	
Door	7,353	.....	.....	29,000	
Oconto	2,622	.....	.....	42,200	
Marinette	68,459	.....	373	53,700	
Ashland	15,012	22,542	.....	33,600	
Bayfield	33,194	.....	.....	24,000	
Douglas	496,431	.....	.....	74,500	
Minnesota	949,162	42,828	293,377	404,700	
Cook	.....	.....	.....	.....	
Lake	11,696	3,805	.....	10,300	
St. Louis	905,898	33,689	293,377	328,000	
Carlton	30,422	.....	.....	34,000	
Pine	1,146	5,334	.....	32,400	
Total	15,424,128	4,610,231	356,505	9,225,200	29,616,064

Illinois consume nearly 50 per cent of the coal consumed by four important consumer groups; in Wisconsin, it is about 67 per cent. These counties lie in the area served by lake ports and which obtain their coal as cheap or more cheaply by lake transportation than is possible by all-rail haul from southern or southwestern Illinois. Although the distribution of lake cargo coal is not confined to the lake shore areas, nevertheless the bulk of the coal from this source is disposed of here. This leaves the remaining interior market the logical outlet for Illinois coal.

NATURE OF THE INTERIOR MARKET

Within the area thus delimited, the domestic coal market is complicated by competition from local coal supplies, a widening net work of natural gas lines, furnace and fuel oil, coke, and western Kentucky coal. Never before

have the number of types of fuels available for domestic use been so large nor has the potential supply been so abundant. Changing conditions of fuel supply have been accompanied by changes in consumer demand. The householder is becoming more exacting. He is examining the several fuels offered for domestic heating on a basis of

(a) Cost—including cost of fuel and heating equipment.
(b) Quality—heat value, ash content, cleanliness (smoke free and soot free properties).
(c) Convenience—automatic operation, ash removal and servicing of heating plants.

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