STATE OF ILLINOIS
ADLAI E. STEVENSON, *Governor*
DEPARTMENT OF REGISTRATION AND EDUCATION
C. HOBART ENGLE, *Director*

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*
URBANA

REPORT OF INVESTIGATIONS — NO. 157

AN ECONOMIC STUDY OF FUELS IN MANUFACTURING

BY

WALTER H. VOSKUIL

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I. INTRODUCTION

1. Purpose and Significance of the Study

More than ordinarily detailed analyses of the role of fuels in manufacturing is possible through the use of reports made by the Bureau of the Census in several years from 1909 to 1947. The Census of Manufactures for 1947 gave separate statistics on bituminous coal, anthracite, coke, fuel oil, gas and other fuels (principally gasoline, wood, and liquefied petroleum gas) consumed in each manufacturing plant for power and heat. Statistics were also given on the quantity of electric energy purchased, the quantities generated in the plant, and the quantities sold.

This report by the Bureau of the Census enables us to ascertain the amount and kind of each fuel used per employee, by industries or industry groups; the role of electric power, the quantities used by workers, and the change since 1939; the cost of fuels as a part of the manufacturing process, compared with value added by manufacture, wages paid, or cost of materials; comparative fuel costs; and the competitive trend among fuels.

The Census of Manufactures covers some 450 individual manufacturing industries classified into 20 major industry groups which are in turn divided into 141 subgroups. This grouping into major industry categories affords a convenient means for studying the fuel- and power-consuming characteristics of related industries and also for studying the fuel and power use of any single industry that may have unusual characteristics in these respects.

The items which are most useful in analyzing the fuels and power used in manufacturing are these four:

Number of employees.
Wages paid.
Value added by manufacture.
Costs of materials and supplies.

The cost of fuels and electric power is one among several items of cost that closely concerns the manufacturer. As is shown in the detailed analyses that follow, this item of fuel costs as a part of the cost of production varies in importance; it is sometimes negligible and sometimes major.

2. Fuels Used in Manufacturing

Kinds and Quantity. The kinds and quantity of fuels used in manufacturing (Table 1) are reproduced from Table 1, Chapter VIII of Vol. I, General Summary, Census of Manufactures.

Table 1

Fuels Consumed and Electric Energy Purchased, and Generated by Manufacturing Industries, 1947 and 1939

"Electric energy generated" is not to be added to the total since, presumably, it is made from fuels included in the table.

Kind	*Unit of measure*	*Fuels and electric energy produced* 1947 *Quantity*	1947 *Cost in thousands*	1939 *Quantity*
Bituminous coal	M tons	103 788	$647 958	57 170
Anthracite	M tons	7 081	44 869	4 971
Coke	M tons	66 171	729 403	35 001
Fuel oils	M barrels	166 947	474 945	97 362
Gas				
Natural	Mill. cu ft	1 238 311	210 637	633 245
Manufactured	Mill. cu ft	1 347 763	82 921	1 185 633
Mixed	Mill. cu ft	1 418 879	89 611	21 528
Other fuels	not available	not available	96 457	not available
Electric energy				
Purchased	Mill. kw-hr	102 822	954 717	44 847
Generated	Mill. kw-hr	43 936	.....	28 593
Generated and sold	Mill. kw-hr	5 811	.....	2 922

Conversion to a Common Equivalent. It is useful to compare coal, lignite, oil, electric power, and various kinds of gas. Two ways in which this can be done are widely used: (1) conversion of all units to equivalent value of coal; and (2) conversion to British or metric thermal units. Both methods have disadvantages. The first does not adequately provide for a realistic comparison between fuels and hydroelectric power. The second, because it calls for the use of tiny units of energy,

Table 2

Conversion Factors for Fuels

Fuel	*Unit*	*Heat value, 1000 ton-calories per unit*[a]	*Electricity equivalent, 1000 kw-hr per unit*[b]
Coal			
Germany	Metric ton	7.0	1.63
Other	Metric ton	7.2	1.68
Brown coal and lignite			
Czechoslovakia	Metric ton	4.9	1.14
Germany	Metric ton	2.2	.51
Other	Metric ton	2.8	.65
Peat	Metric ton	3.6	.84
Coke	Metric ton	6.0	1.40
Coal briquettes	Metric ton	7.2	1.68
Lignite briquettes			
Czechoslovakia	Metric ton	7.0	1.63
Other	Metric ton	4.8	1.12
Fuelwood	Cubic meters	1.8	.42
Mineral oil and derivative oil fuels	Metric ton	10.6	2.47
Benzol	Metric ton	10.6	2.47
Alcohol	Metric ton	5.5	1.28
Natural gas	1000 cubic meters	9.6	2.24
Manufactured gas	1000 cubic meters	4.3	1.00
Refinery gas	1000 cubic meters	12.5	2.91
Blast-furnace gas	1000 cubic meters	.8	.19
Electricity	1000 kw-hr	.86	1.00

[a] 1 ton-calorie = 1000 kg cal.
[b] At approximately 20 percent efficiency, except electricity (100 percent).

involves numbers which are too large to be easily comprehended and which are therefore virtually meaningless to most people. Neither method, as usually applied, gives adequate consideration to the efficiency with which fuel and power are utilized.

The present discussion uses a method employed by the State Department in its report on "Energy Resources of the World" (Publication 3428, 1949, page 123) and also by Pavel and Bodea in "Power Resources of Roumania, Their Development and Utilization" (Transactions of the Third World Power Conference). This method deviates from others by less than 1 percent.

Table 3

Conversion Factors for Fuel Units Used in the United States

Coal	1.5272 per ton
Lignite	.6896 per ton
Coke	1.2704 per ton
Coal briquettes	1.5272 per ton
Mineral oils[a]	2.24138 per ton
	.353 per barrel
Natural gas	.06344 per M cu ft
Benzol—same as mineral oils	
Alcohol	.0038 per gallon
Manufactured gas	.02832 per M cu ft
Blast-furnace gas	.0054 per M cu ft
Refinery gas	.0824 per M cu ft

[a] In converting from tons to barrels, the following conversion factors have been used:

Motor gasoline and natural gasoline	8.50
Kerosene	7.75
Gas, oil, diesel, and distillate fuel	7.25
Residual fuel oil	6.66
Mineral oils, unspecified	7.00
Benzol	7.14

The essence of the method is that the various fuels are converted into kilowatt hours. "The selection of the kilowatt hour as a unit of energy is based on its constant value, its convertibility to heat, light, or power. . . . Twenty percent is selected as the efficiency factor because this portion of the energy contained in any fuel can be made available, for most purposes, by using the fuel to generate electricity; and it is estimated that, on the average, 20 percent of the energy available in fuels is now utilized" (Pavel and Bodea).

The values used, on this basis, in equating specific sources of energy to electricity are shown in Table 2.

The units in the foregoing table (metric tons and cubic meters) are converted in Table 3 to short tons, cubic feet, or gallons.

Meaning of Unit Cost. Throughout this discussion, the unit of energy comparison employed is the kilowatt-hour equivalent. Unit cost therefore is the cost per thousand kw-hr into which the fuel in question has been converted. Thus, if 10,083,000 tons of coal used in the blast furnace and steel-mill industry cost $50,634,000, or $5.02 per ton, the 15,830,310 M kw-hr equivalent of 10,083,000 tons would cost $3.20 per unit of fuel.

II. GENERAL SURVEY OF FUELS IN MANUFACTURING

3. Consumption by Manufacturing Groups

This chapter presents tables and charts showing several relationships of fuels to employment and to other items reported in the Census of Manufactures. For each of the industry groups, the tables include fuels and power used per production worker; average wage per worker; value added by manufacture per worker; fuel cost in relation to wages paid; and fuel cost in relation to value added by manufacture.

The fuels and power used in manufacturing are expressed in equivalent kilowatt-hours. They comprise all types of fuels used in each of the manufacturing groups, and also purchased electric power.

Table 4 shows the quantities of fuel and power used by each of the manufacturing groups, and the percentage distribution of fuel and power needs. To be noted particularly is the high consumption in the following industries: primary metals; chemicals; stone, clay, and glass; and petroleum and coal products.

Table 4

Fuel and Power Consumption, by Manufacturing Industry Groups, 1947

Converted to million kilowatt-hours, according to the conversion units in Table 2.

Industry no.	*Industry group*[a]	*Mill. kw-hr equivalent*	*Percent of total*
20	Food and kindred products	44 056	7.4
21	Tobacco manufactures	979	0.1
22	Textile mill products	23 161	3.9
23	Apparel and related products	2 259	0.4
24	Lumber and products, except furniture	11 808	2.0
25	Furniture and fixtures	2 659	0.4
26	Paper and allied products	38 960	6.6
27	Printing and publishing industries	2 685	0.4
28	Chemicals and allied products	61 573	10.4
29	Petroleum and coal products	44 595	7.4
30	Rubber products	8 144	1.4
31	Leather and leather products	2 725	0.4
32	Stone, clay and glass products	54 000	9.0
33	Primary metal industries	238 827	40.2
34	Fabricated metal products	11 689	2.0
35	Machinery (except electrical)	17 271	2.8
36	Electrical machinery	8 187	1.2
37	Transportation equipment	18 038	3.2
38	Instruments and related products	1 358	0.2
39	Miscellaneous manufactures	3 485	0.6
	Total	596 459	100.0

[a] Census numbering and classification. The left-hand columns of Tables 5, 6, 8–10, 15, and 16 use the same numbers.

4. Fuels and the Production Worker[1]

The extent to which fuels and power are used by workers in industry is shown in Table 5 for the 20 groups of industries as classified by the Census Bureau. The table points up the great contrast in quantities of fuel and power used by workers. To be noted particularly are the following industries: primary metals; paper and allied products; chemicals; stone, clay, and glass; and petroleum and coal.

In this table calculations of the average income per worker and value added by manufacture have been entered. There is no definite relationship discernible from the summary figures to indicate a correlation between income of production workers and amount of power used. This apparent lack of correlation also exists in the case of value added by manufacture.

5. Fuel Costs

The cost of fuels and power in manufacturing can be evaluated to a certain extent by comparison with two other items available in the Census reports—wages and salaries paid, and value added by manufacture. The relationship of fuel and power costs to these two items is shown in Table 6. To be noted particularly are the five groups of industries in which fuel and power cost is an important factor: primary metals; paper and allied products; chemicals; stone, clay, and glass; and petroleum and coal.

[1] The term "production worker" is here taken to comprise working foremen and all nonsupervisory workers closely associated with production operations. It does not include construction employees or sales, technical, office, and administrative personnel.

Table 5

Fuel and Power Used per Production Worker, 1947

Ind. no.	*Industry group*	*No. of production workers*	*Fuel and power used, mill. kw-hr equivalent*	*Fuel and power used per worker, kw-hr equivalent*	*Average wage*	*Value added by manufacture, per worker*
20	Food and kindred products	1 099 478	44 056	40 080	$2 340	$6 020
21	Tobacco manufactures	103 289	979	9 480	1 700	6 200
22	Textile mill products	1 147 194	23 161	20 190	2 140	4 650
23	Apparel and related products	972 879	2 259	2 322	2 080	4 560
24	Lumber and products	596 118	11 808	20 000	1 970	4 180
25	Furniture and fixtures	282 780	2 659	9 400	2 320	4 850
26	Paper and allied products	388 901	38 960	100 000	2 595	7 380
27	Printing and publishing	438 135	2 685	6 130	3 000	9 740
28	Chemicals and allied products	466 458	61 573	130 000	2 670	11 500
29	Petroleum and coal	169 610	44 595	236 516	3 280	12 000
30	Rubber products	214 533	8 144	38 000	2 820	6 050
31	Leather and leather products	348 529	2 725	8 000	2 080	4 400
32	Stone, clay and glass	405 755	54 000	133 000	2 350	5 700
33	Primary metal industries	1 010 055	238 827	236 450	2 940	5 700
34	Fabricated metal products	822 514	11 689	14 200	2 660	5 980
35	Machinery (except electrical)	1 244 135	17 271	14 000	2 980	6 290
36	Electrical machinery	639 147	8 187	12 800	2 580	6 080
37	Transportation equipment	987 142	18 038	18 250	2 970	5 930
38	Instruments and related products	181 939	1 358	7 464	2 570	5 950
39	Miscellaneous manufactures	397 579	3 485	8 800	2 320	5 250
	All industries	11 916 188	596 459	50 000	2 540	6 250

Table 6

Cost of Fuel, Wages and Salaries Paid, and Value Added by Manufacture

Ind. no. (1)	*Industry group* (2)	*Cost of fuels and power, in thousands* (3)	*Wages and salaries paid, in thousands* (4)	*Percent* (3) *is of* (4) (5)	*Value added by manufacture, in thousands* (6)	*Percent* (3) *is of* (6) (7)
20	Food and kindred products	$ 278 783	$ 3 789 387	7.35	$ 9 024 912	3.09
21	Tobacco manufactures	6 036	205 838	2.94	641 356	0.94
22	Textile mill products	166 942	2 836 166	5.85	5 340 876	3.12
23	Apparel and related products	29 728	2 527 499	1.17	4 443 373	0.67
24	Lumber and products	67 798	1 337 612	5.08	2 497 192	2.72
25	Furniture and fixtures	21 568	824 061	2.62	1 377 908	1.56
26	Paper and allied products	198 276	1 280 672	15.50	2 874 958	6.90
27	Printing and publishing	35 205	2 277 263	1.55	4 269 416	0.82
28	Chemicals and allied products	296 604	1 910 463	15.55	5 365 201	5.52
29	Petroleum and coal	96 691	739 345	13.1	2 015 307	4.81
30	Rubber products	45 912	783 464	5.86	1 302 863	3.53
31	Leather and leather products	20 718	837 566	2.47	1 532 803	1.35
32	Stone, clay and glass	257 748	1 210 768	21.2	2 306 480	11.15
33	Primary metal industries	1 317 136	3 594 548	36.6	5 765 434	22.80
34	Fabricated metal products	111 008	2 832 835	3.92	4 921 476	2.26
35	Machinery (except electrical)	146 971	4 804 563	3.06	7 812 455	1.88
36	Electrical machinery	64 420	2 271 039	2.84	3 894 115	1.66
37	Transportation equipment	124 695	3 719 583	3.35	5 869 196	2.12
38	Instruments and related products	12 459	665 347	1.87	1 080 336	1.15
39	Miscellaneous manufactures	33 270	1 205 208	2.76	2 090 168	1.59
	All industries	3 331 518	39 689 527	8.39	74 425 825	4.34

III. ELECTRIC POWER IN MANUFACTURING

The use of electricity in manufacturing has increased from a net amount of 70,518 million kw-hr in 1939 to a total net of 140,947 million kw-hr in 1947[1] (Table 7). This includes both electric power generated by the manufacturing industries themselves and that purchased from electric utilities. This doubling of electric power requirements by manufacturing industries in an eight-year interval is of interest to the electric

Table 7

Electric Power Used in Manufacturing, 1939 and 1947

In millions of kilowatt-hours

	1939	*1947*	*Percent change*
Electric power purchased	44 847	102 822	129
Electric power generated	28 593	43 936	52
Total	73 440	146 758	...
Less sales	2 922	5 811	...
Net total	70 518	140 947	100

power industry; it is of special interest to know just where the increases have occurred and what (if any) clue the Census data give as to future trends.

A summary of the statistical position of electric power in manufacturing is given below.

The extent to which electric power is used in manufacturing is indicated in Table 8, showing total fuels and power used in manufacturing stated in kilowatt-hour equivalents, and the proportion of this which is used in the form of electric power. As would be anticipated, the proportion of electric power used is highest in those industries where the principal fuel and power requirements are for mechanical operation rather than for heat processing operations.

Table 9 shows electric power, in kilowatt-hours per worker, used in industry groups in 1939 and 1947. The intervening period of eight years shows an over-all increase of 30 percent. Without doubt, there has been an increase in the number or size of electric motors at the disposal of the workmen, or further replacement of hand operations by power-driven operations. This change, however, is not an adequate explanation

[1] Net consumption is here defined as the electric power generated plus electric power purchased less electric power sold.

Table 8

Fuels and Electric Power Used in Industry, 1947

Ind. no.	Industry group	Total power used, mill. kw-hr equivalent	Electric power used, mill. kw-hr equivalent	% electric power of total power used
20	Food and kindred products	44 056	10 180	23.1
21	Tobacco manufactures	979	219	22.4
22	Textile mill products	23 161	10 041	43.3
23	Apparel and related products	2 259	850	37.8
24	Lumber and products	11 808	2 338	19.8
25	Furniture and fixtures	2 659	826	31.0
26	Paper and allied products	38 960	15 386	39.4
27	Printing and publishing	2 685	1 280	47.6
28	Chemicals and allied products	61 573	19 610	31.8
29	Petroleum and coal	44 595	6 498	14.6
30	Rubber products	8 144	3 445	38.7
31	Leather and leather products	2 725	573	21.0
32	Stone, clay and glass	54 000	7 898	14.6
33	Primary metal industries	238 827	40 645	17.0
34	Fabricated metal products	11 689	3 901	33.4
35	Machinery (except electrical)	17 271	5 921	34.3
36	Electrical machinery	8 187	3 616	44.1
37	Transportation equipment	18 038	6 061	34.6
38	Instruments and related products	1 358	545	40.1
39	Miscellaneous manufactures	3 485	1 114	32.0
	Total	594 659	140 947	23.7

for the unusual increase in electric power use in Group 33, Primary Metal Industries. Two items in the group—No. 3313 Electrometallurgical Products, and No. 3334 Primary Aluminum—are particularly heavy users of electric power. Together these two industries use 37 percent of all electric power used by the primary metals group (see Table 10).

The effect upon electric power consumption of the rapid development of aluminum manufacture after 1939 and the doubling of output of electrometallurgical steel are summarized in Table 11, which shows the quantities of electric power used for aluminum reduction and electric steel making in 1939 and 1947 and the change in positions of these industries as between these two census years.

This table makes clear the effect of increased aluminum reduction and electric steel manufacture since 1939. When the electric power used in the two above-named industries is subtracted from the total, the remaining quantities show (1) an increase of 1947 over 1939 which is comparable to the increase in all manufacturing industries; and (2) an increase in the use of electric power per worker of 50 percent over the 1939 level (see Table 10)—indicating that, in addition to unusual developments in the field of electrometallurgy, there has been a more than average growth in electric power use in the primary metal industries.

Table 9

Electric Power Used per Worker, 1939 and 1947

Ind. no.	*Industry group*	*No. of workers, 1939*	*No. of workers, 1947*	*Electric power used, mill. kw-hr, 1939*	*Electric power used, mill. kw-hr, 1947*	*Electric power used per worker, kw-hr, 1939*	*Electric power used per worker, kw-hr, 1947*	*Percent change*
20	Food and kindred products	802 133	1 099 478	6 388	10 180	7 950	9 240	16.2
21	Tobacco manufactures	87 525	103 289	115	219	1 310	2 120	61.8
22	Textile mill products	1 081 710	1 147 194	6 805	10 041	6 300	8 730	38.6
23	Apparel and related products	752 829	972 897	353	850	470	874	86.0
24	Lumber and products	422 947	596 118	1 238	2 338	2 892	3 920	35.5
25	Furniture and fixtures	189 382	282 780	605	826	3 200	2 920	-8.8
26	Paper and allied products	270 239	388 901	9 394	15 386	34 750	39 550	13.8
27	Printing and publishing	324 371	438 135	859	1 280	2 650	2 920	10.2
28	Chemicals and allied products	275 669	466 458	9 811	19 610	35 700	42 000	17.6
29	Petroleum and coal	107 695	169 610	3 440	6 498	32 000	38 300	19.7
30	Rubber products	120 740	214 533	1 584	3 445	13 200	16 100	18.0
31	Leather and leather products	327 189	348 529	402	573	1 230	1 640	33.3
32	Stone, clay and glass	267 094	405 755	4 852	7 898	18 200	19 400	6.6
33	Primary metal industries	672 438	1 010 055	18 291	40 645	16 140	40 100	172.0
34	Fabricated metal products	451 087	822 514		3 901		4 740	
35	Machinery (except electrical)	536 082	1 244 135	1 985	5 921	3 700	4 750	28.4
36	Electrical machinery	247 930	639 147	1 432	3 616	5 780	5 640	-2.4
37	Transportation equipment	544 553	987 142	2 950	6 061	5 420	6 150	13.5
38	Instruments and related products	84 867	181 939	.. ...	545	.. ...	3 000	.....
39	Miscellaneous manufactures	241 725	397 579	.. ...	1 114	.. ...	2 800	.....
	Total	7 808 205	11 916 188	70 869	140 947	9 080	11 830	30.3

Table 10

Electric Power Used by the Primary Metal Industries, 1947

Ind. no.	*Industry group*	*Number of workers*	*Electric power used, mill. kw-hr*	*Electric power per worker kw-hr*	*Percent*
3311	Blast furnaces	32 697	1 425	43 500	3.5
3312	Steel works and rolling mills	438 088	15 391	35 000	37.9
3313	Electrometallurgical products	8 175	4 903	600 000	12.0
3321	Gray-iron foundries	157 361	966	6 160	2.4
3322	Malleable-iron foundries	26 659	236	9 000	0.6
3323	Steel foundries	55 252	1 062	19 200	2.5
3331	Primary copper	13 065	738	56 500	1.9
3332	Primary lead	4 022	141	35 000	0.3
3333	Primary zinc	11 088	1 473[a]	133 000	3.6
3334	Primary aluminum	7 336	10 270[a]	1 400 000	25.4
3339	Primary non-ferrous metals, n.e.c.	1 885	32	17 000	0.1
3341	Secondary non-ferrous metals	14 750	156	10 500	0.3
3351	Copper rolling and drawing	45 924	987	21 500	2.5
3352	Aluminum rolling and drawing	22 786	970	42 500	2.5
3359	Non-ferrous rolling, n.e.c.	6 086	132	21 700	0.3
3361	Non-ferrous foundries	57 469	295	5 000	0.8
3391	Iron and steel forgings	32 384	296	9 140	0.8
3392	Wire drawing	45 644	714	15 600	1.7
3393	Welding and heavy riveted pipe	11 305	135	12 000	0.3
3399	Primary metal industries, n.e.c.	18 078	323	17 900	0.9
	Total		40 645		

[a] Partly calculated.

Table 11

Electric Power Used in the Production of Aluminum and Electric Steel

In millions of kilowatt-hours

	1939		*1947*
Group 33—Primary Metal industries	18 281		44 546
Aluminum reduction	2 943[a]	10 270	
Electric steel furnaces	1 740[b]	4 903	
Total of aluminum and steel	4 683		15 173
Difference: all other primary metals	13 608		29 373
Number of employees in "all other primary metals"	696 862		999 995
Electric power used per "other" employees	19 500		29 400

[a] Electric power calculated for 1939 on a basis of 9 kw-hr of electric power to reduce 1 lb of aluminum.

[b] Calculated on the basis of the same rate of electric power consumption per ton of steel in 1939 as in 1947.

IV. FUELS AND POWER IN THE IRON AND STEEL INDUSTRIES

6. Fuels for Iron Reduction

The fundamental fact that must be grasped in considering iron supply for industry is that iron is as much a product of fuel as it is of the metal-bearing ore itself. Moreover, it is equally essential to understand that in the process of manufacturing—from ore to finished automobile, corn planter, or Boy Scout knife—the fuel that is needed to get over the first step of converting the ore to the pig-iron and steel-ingot stage seems like an inordinately large part of the total fuels needed in manufacture; it is about 33 percent. Moreover, the fuel that can be used in the large-scale blast furnace for the production of iron on a large scale must be a hard, porous, strong load-bearing coke which is made from coal.

Nor have we as yet included all the necessary factors. This coke must be low in sulfur, to keep the percentage of the harmful material to a very small percentage in the resultant pig iron. While all other steps in manufacturing can, with occasional exceptions, use oil and gas as well as coal for the needed fuel requirements, the initial step in the manufacturing process—getting the metal out of the ore—can be taken, for all practical purposes, only with coke from coal. This fuel is so special and exacting in its nature that a special term, "coking coal," is applied to those coals from which coke or (more narrowly) metallurgical coke can be made.

In view of these many circumscribing factors, we realize with a start that, although the coal deposits of the nation are extensive and well distributed, yet the supply of coking coals and the districts in which they are found are very restricted.

7. Fuels and Power in the Iron and Steel Industries Compared to Total Fuel Requirements in Manufacturing

Among the 20 manufacturing industry groups, the one listed as primary metal industries is by far the largest user of fuels and power; and within this group the iron and steel industries are dominant.[1] A

[1] In this analysis, the manufacturing industries included under iron and steel are blast furnaces, steel works and rolling mills, and electrometallurgical products, but not gray-iron foundries, malleable-iron foundries, and steel foundries.

Table 12

Summary of Fuels Used in Iron and Steel Manufacture[a]

Fuel	*Quantity converted into M kw-hr*[b]	*Percent*
Bituminous coal	15 830 310	8.0
Anthracite	841 520	0.4
Coke	75 177 650	37.9
Fuel oils	17 806 732	9.0
Natural gas	4 817 126	2.5
Manufactured gas	28 311 858	14.5
Mixed gas	37 158 134	18.7
Electric power	14 256 000	7.0
Other fuels	3 800 670[c]	2.0
Totals	198 000 000	100.0

[a] No. 331 by Census classification.
[b] Converted from original fuel units according to conversion units in Table 2.
[c] Calculated.

summary of the position of these industries as consumers of fuel and power among all manufacturing industries is given in Table 4.

When taken alone, iron and steel use one-third of the fuels and power used by all the manufacturing groups. The group comprising primary metals—which includes also iron and steel foundries and primary copper, lead, zinc, aluminum, and other minor metals—uses 40 percent of the total fuels and power utilized.

8. Fuels Used in Iron and Steel Making

Fuels used in the production of pig iron and steel are bituminous coal, anthracite, coke, fuel oil, natural gas, manufactured gas, mixed gas, tar, and electric power. Though all are derived from primary fuel sources, bituminous coal, anthracite, natural gas, petroleum and water power, yet the largest quantities used in iron and steel making are the processed fuels—coke and manufactured gas. The contribution of each of the fuels is shown graphically in Table 12.

9. The Fuel Structure of the Iron and Steel Industries

The three most prevalent types of fuels and power applications required in the manufacture of iron and steel are fuels for reducing iron ore, fuels for reheating steel in the process and manufacture, and power (mainly electrical) for operating machinery. Only metallurgical coke can be used for reducing iron ore to the free metal. Gas and fuel oil are both used for heating and reheating steel. Electric power is both purchased and produced by the industry. The contribution of anthracite is insignificant. The key factor in the fuel requirements of the iron and steel industry is the production and use of metallurgical coke.

To supply the blast furnace with suitable fuel, a special fuel processing industry—the manufacture of coke—must be set up. This involves a considerable investment and processing cost, which is reflected in a relatively high unit cost of fuel used in the reduction of iron ore.

The processing of coal into coke and the manufacture of pig iron in the blast furnace result in the production of by-product gaseous fuels and tar, which are useful in the subsequent operation of steel manufacture. These fuels are (1) coke oven gas, consisting mainly of hydrogen and methane, with a net Btu content of about 500; (2) blast furnace gas, mainly carbon monoxide, carbon dioxide and nitrogen, with a net Btu content of less than 100; and (3) oven tar. Gaseous by-products from the coke ovens and blast furnaces are used in part to heat the ovens and

Table 13

Fuel Requirements in Coke Ovens, Blast Furnaces, and Steel Works and Rolling Mills

In millions of kilowatt-hour equivalent

	Coke ovens		*Blast furnaces*		*Steel works and rolling mills*	
	quantity	*percent*	*quantity*	*percent*	*quantity*	*percent*
Bituminous coal	653	5.8	1 509	2.0	13 317	11.3
Anthracite	140	1.3	295	0.4	545	0.4
Coke	52	0.5	72 767	95.2	1 886	1.6
Fuel oils	212	1.9	96	....	17 699	15.1
Natural gas	151	1.3	69	....	4 730	4.0
Manufactured gas	216	65.0	634	0.9	27 682	23.5
Mixed gas	761	6.7	121	0.2	37 037	31.2
Electric power	606	5.5	679	0.9	9 956	8.5
Other[a]	1 336	12.0	305	0.4	5 148	4.4
Totals	11 127	100.0	76 475	100.0	118 000	100.0

[a] Principally gasoline, liquefied petroleum gas, and coal tar.

the stoves and also to run the air compressors, but mainly these fuels go to the steel works and rolling mills to supply heat in the several processing steps. The detailed distribution of fuel use, by types, in the three stages of the primary iron and steel industry is shown in Table 13. It is to be noted that, while by-product fuels make an important contribution to fuel requirements of steel work and rolling mills, additional fuel is needed. This is supplied by coal, fuel oil, natural gas, and electric power.

10. Cost of Fuels

The distinctive characteristic of the primary iron and steel is the large quantities of fuel and power required in the process of freeing the metal from the ore, as shown by a comparison of key cost items (Table 14).

Another way of looking at the relationship of fuel costs in the iron and steel industry is to compare them with wages paid and value added by manufacture. In this industrial group the cost of fuel is 62.0 percent of the money paid out in wages and salaries, whereas for *all* manufacturing industries it is only 8.4 percent. Table 15 shows, for the twenty manufacturing groups, the costs of fuels used, the number of employees, and wages paid. Table 16 gives a further analysis for the elements comprising the primary-metals group.

Table 14

Place of the Iron and Steel Industries with Respect to Cost of Fuel and Related Factors

	All industries	*Iron and steel industry*[a]	*Iron and steel, percent of total*
Cost of fuel, in thousands	$3 331 518	$1 075 323	32.80
Number of employees	14 294 304	547 364	3.84
Wages and salaries paid, in thousands	$39 689 527	$1 735 111	4.37
Value added by manufacture, in thousands	$24 487 304	$1 250 499	5.10
Fuel used per worker per year, kw-hr equivalent	41 700	360 000	....
Cost of fuel per worker	$225	$1 140	....
Cost of fuel per unit[b]	$5.61	$5.43	....

[a] No. 331 under the Census classification.
[b] M kilowatt-hour equivalent.

Table 15

All Industries: Ratio of Fuel Costs to Wages and Salaries

All money values in thousands

Ind. no.	*Industry group*	*Cost of fuel*	*No. of workers*	*Cost of fuel per worker*	*Salaries and wages paid*	*Fuel % of wages*
20	Food and kindred products	$278 783	1 441 837	$193	$3 789 387	7.3
21	Tobacco manufactures	6 036	111 782	54	205 838	2.9
22	Textile mill products	166 492	1 233 431	135	2 836 166	5.9
23	Apparel and related products	26 728	1 081 444	25	2 527 499	1.2
24	Lumber and products	67 798	635 708	10.6	1 337 612	5.1
25	Furniture and fixtures	21 568	322 384	67	824 061	2.6
26	Paper and allied products	198 276	449 833	440	1 280 672	15.5
27	Printing and publishing	35 205	715 450	49	2 277 263	1.5
28	Chemicals and allied products	296 604	632 319	469	1 910 463	15.5
29	Petroleum and coal	96 691	212 003	466	739 345	13.1
30	Rubber products	45 912	259 092	177	783 464	5.9
31	Leather and leather products	20 718	383 175	54	873 566	2.5
32	Stone, clay and glass products	257 748	462 072	556	1 210 768	21.3
33	Primary metal industries	1 317 136	1 157 124	1 140	3 594 548	36.7
34	Fabricated metal products	111 008	971 461	114	2 832 835	3.9
35	Machinery (except electrical)	146 971	1 545 323	95	4 304 563	3.1
36	Electrical machinery	64 420	801 359	80	2 271 039	2.8
37	Transportation equipment	124 695	1 181 680	105	3 719 583	3.3
38	Instruments and related products	12 459	231 997	53	665 347	1.9
39	Miscellaneous manufactures	33 270	464 420	72	1 205 508	2.8
	All industries	3 331 518	14 294 304	225	39 689 527	8.4

Table 16

Steel Industries: Ratio of Fuel Costs to Wages and Salaries

All money values in thousands

Ind. no.	*Industry group*	*Cost of fuel*	*No. of employees*	*Cost per employee*	*Salaries and wages paid*	*Percent*
33	Primary metal industries	$1 317 136	1 157 124	$1 140	$3 594 548	36.6
331	Blast furnaces and steel mills	1 075 323	547 364	1 960	1 735 111	62.0
3311	Blast furnaces	634 111	36 937	17 180	112 018	566.6
3312	Steel works and rolling mills	419 991	500 799	840	1 593 808	26.4
3313	Electrometallurgical products	21 221	9 628	2 305	29 285	76.0
332	Iron and steel foundries	83 590	267 306	302	792 485	10.5
3321	Gray-iron foundries	49 909	173 776	289	512 177	9.8
3322	Malleable-iron foundries	11 651	29 862	386	90 811	12.7
3323	Steel foundries	22 130	63 668	347	190 497	11.6
333	Primary non-ferrous metals	59 968	42 804	1 400	127 026	47.2
3331	Primary copper	14 772	14 629	1 000	44 790	33.0
3332	Primary lead	6 517	4 663	1 410	14 082	46.3
3333	Primary zinc	14 389	12 424	1 150	35 476	40.5
3334	Primary aluminum	23 246	8 914	2 610	26 398	88.0
3339	Primary non-ferrous metals, n.e.c.	1 044	2 169	480	6 280	18.6
	All industries	3 331 518	14 253 304	225	39 689 327	8.4

11. Blast Furnace Fuel Costs

In the process of pig-iron manufacture, the most important cost items are fuels and materials; direct labor costs (wages paid) are considerably less. In an over-all report on the industry for the year 1947, the Bureau of the Census (in Vol. II of its Census of Manufactures) gives the division of costs as shown below in Table 17.

The Census report shows a recovery of blast-furnace gas equivalent in fuel value to 10,072,830 tons of coal and valued at $52,925,000. Of this, nearly all is disposed of in interplant transfer. The report does not, however, state the details of the disposition of this gas. There are several possible outlets: gas to heat the coke ovens; fuel to operate the

Table 17

Pig Iron Cost Data

Pig iron produced, net tons	58 339 942
Value of pig iron produced	$1 708 313 000
Value, per ton	$29.28
Cost of fuel in pig-iron production	$634 111 000[a]
Less values of blast-furnace gas recovered and sold	$52 925 000
Net fuel cost	$581 186 000[b]
Net fuel cost per ton of pig iron	$ 9.96
Wages and salaries paid	$111 413 000
Wages and salaries per ton of pig iron	$ 1.90
Cost of materials, parts, containers, and supplies (mainly ore)	$751 673 000
Cost per ton	$12.88
Value added by manufacture	$328 060 000
Value added per ton	$ 5.61

[a] Percentage of value of product—37.1 percent.
[b] Percentage of value of product—34.0 percent.

compressors in the blast-furnace plant; and fuel to heat the stoves. The gas could also be used at various reheat operations in the adjoining steel plant; if so, the value of the fuel thus used should be deducted from the gross cost of the fuel in the operation of blast furnaces. The data available in the published reports do not enable us to make this deduction.

Because fuel costs comprise so large a proportion of the costs of pig-iron production, analysis should be carried further. We should like to know the cost of coke, what elements comprise this cost, and—if an estimate is possible—what further changes may be expected.

Three elements are significant in the cost of coke delivered at the blast-furnace plant: (1) mine price of coal; (2) transportation costs from mine to coke plant; and (3) cost of processing coal into coke.

Location of Coking Coal Deposits. Coal suitable for the manufacture of coke is somewhat restricted in its distribution. Currently, 90 percent of coal used for the manufacture of coke is obtained from four states—West Virginia, Pennsylvania, Kentucky, and Alabama. Coke for the western steel industry is obtained from Utah, Colorado, and New Mexico. Interest therefore centers on the location of coking coal resources.

For the years 1948 and 1949, the sources of coal used (in tons) for oven coke manufacture were as follows (source: Bureau of Mines, *Minerals Yearbook*).

	1948	*1949*
West Virginia	36,318,250	32,638,773
Pennsylvania	32,278,200	27,371,938
Kentucky	14,573,772	11,316,015
Alabama	8,822,325	7,065,913
Virginia	2,507,608	2,528,847
Partial Total	94,500,155	80,921,486
Western States (Utah, Colorado, New Mexico)	3,529,512	2,976,447
Other States	2,343,060	1,781,791
Total	100,372,727	85,679,724

Mine Price of Coking Coal. Table 18 shows the mine price of coal, by counties, for 1947.

Transportation Costs. Freight-rate increases during 1947, 1948, and 1949 affected considerably the delivered price of coal. The extent of these changes is indicated by two examples of increases in the rates from coking-coal districts to the Chicago market.

	Rail Rates in Effect			
	Dec. 1946	*Dec. 1947*	*Dec. 1948*	*Dec. 1949*
New River and Pocahontas	$3.69	$3.79	$4.09	$4.44
Eastern Kentucky, West Virginia high volatile	$3.49	$3.59	$3.89	$4.25

Cost of Coal and Coke at the Ovens. The combined effect of increased mine prices of coking coal and increases in rail freight on coal is reflected in the increasing costs of coke at the plant. The history of these price changes from 1946 to 1949 for the industry and for leading coke-consuming states is shown in Table 19.

Cost of Coke per Ton of Pig Iron Produced. An attempt has been made in Table 20 to arrive at a cost of coke per ton of pig iron produced in six of the important pig-iron producing states. In arriving at this estimate, the figures for pounds of coke needed to produce a ton of pig iron are available only for the entire industry and not for individual states. This figure varies from year to year, depending upon the changing quality of coal available for the making of coke and also upon changes in operation conditions of the furnaces. It is not to be taken for granted that there are no variations in coke consumption among the several pig-iron producing districts or that changes in coke requirements from year to year are indentical among these districts. The figures in columns (2), (4), and (6) must therefore be regarded as approximations only.

12. Fuels in Steel Works and Rolling Mills

The operations of the steel mill begin at the point where pig iron from the blast furnace, either in solid or in liquid form, is transferred to the steel-making furnaces. As in blast-furnace operation, the fuel requirements are high. Fuel for heat operations is a particularly large

Table 18

Cost of Coke, by Leading Coke-Using Counties, 1947

State and county	*Coke used, M tons*	*Cost, M Dollars*	*Cost per ton*
Massachusetts			
Middlesex	203.4	$2 886.4	$14.21
New York			
Chatauqua	13.6	196.8	14.45
Erie	3 471.5	38 971.3	11.14
Niagara	374.9	4 347.9	11.58
Onondaga	120.3	1 535.8	12.75
Rensselaer	182.6	2 240.7	12.28
Pennsylvania			
Allegheny	10 017.3	97 784.4	9.27
Beaver	2 211.4	18 068.3	8.15
Cambria	1 659.0	16 000.5	9.64
Carbon	145.1	2 041.7	14.10
Dauphin	743.7	7 216.7	9.79
Erie	202.3	2 604.9	12.90
Mercer	848.6	10 855.4	12.45
Montgomery	354.4	3 300.0	9.34
Northampton	1 544.0	17 258.9	11.16
Washington	482.8	4 367.9	9.08
Westmoreland	446.0	9 332.8	9.69
Ohio			
Ashtabula	104.9	1 376.6	13.10
Butler	532.0	3 886.9	7.30
Cuyahoga	2 446.9	27 368.3	11.04
Jackson	176.5	2 125.0	12.05
Jefferson	548.7	2 986.0	5.45
Lawrence	269.6	3 069.6	11.40
Lorain	1 535.3	15 142.9	9.89
Lucas	514.4	6 656.8	12.97
Mahoning	4 854.6	49 622.8	10.20
Scioto	259.2	3 248.7	12.55
Stark	435.9	4 272.3	9.81
Trumbull	590.8	6 051.2	10.22
Indiana			
Lake	6 143.4	79 211.4	12.90
St. Joseph	12.4	229.4	18.48
Illinois			
Cook	5 047.9	68 804.8	13.62
Madison	410.5	6 150.2	14.96
St. Clair	39.8	291.2	7.30
Michigan			
Saginaw	121.6	2 384.3	
Wayne	1 807.6	19 907.3	11.00
Minnesota			
St. Louis	490.7	5 224.2	10.63
Maryland			
Baltimore	2 408.0	25 618.0	10.64
Baltimore City	39.9	660.7	15.21
West Virginia			
Hancock	999.8	6 168.4	6.16
Kanawha	410.7	2 542.1	7.16
Marshall	242.9	1 932.0	7.96
Kentucky			
Boyd	598.0	5 022.7	8.39
Alabama			
Etowah	355.6	3 264.1	9.18
Jefferson	4 602.9	46 711.7	10.15
Colorado			
Pueblo	797.1	8 793.2	11.00
Utah			
Utah	936.5	10 701.5	11.41
California			
Los Angeles	61.8	1 237.8	20.00

requirement. A detailed Census report of fuels used in steel works and rolling mills for the year 1947 gives a cross-section of fuel consumption in this branch of the industry. Fuels used are bituminous coal, anthracite, coke, oil, natural and manufactured gas, and electric power. The quantities of each of these fuels, and their comparative fuel contribution to the steel industry, are summarized in Table 21.

Table 19

Costs of Coal at the Oven, and Value of Furnace Coke[a]

Year	*Cost of coal charged, per ton*	*Average receipts per ton sold (merchant)*
1946	$5.77	$ 8.46
1947	6.78	10.34
1948	8.13	13.02
1949	8.52	13.80

Value of Coke at Ovens, per Ton

Year	*Alabama*	*Illinois*	*Indiana*	*New York*	*Ohio*	*Pennsylvania*
1946	$7.00	$10.20	$8.92	$ 8.79	$ 8.21	$ 7.05
1947	8.02	12.95	13.39	10.34	9.83	10.04
1948	9.58	14.80	14.60	12.79	12.20	11.40
1949	10.75	16.35	16.26	13.37	12.51	12.18
Percentage increase, 1949 over 1947:	26.8	28.14	21.4	29.3	27.3	21.3

Cost of Coal at Ovens, per Ton

1946	$4.96	$ 6.70	$ 6.75	$ 6.71	$ 5.72	$ 4.79
1947	5.57	8.00	8.01	7.76	6.76	5.87
1948	6.58	9.38	9.35	9.48	8.11	7.22
1949	6.81	9.75	9.71	9.83	8.42	7.64
Percentage increase, 1949 over 1947:	22.2	21.9	21.2	26.6	24.5	30.1

[a] Source: Bureau of Mines.

Table 20

Cost of Coke per Ton of Pig Iron Produced

Year (1)	*Quantity of coke used, lb* (2)	*Cost of coke per ton* (3)	*Cost of coke per ton of pig iron* (4)	*Value of pig iron per ton* (5)	*Percentage (4) is of (5)* (6)
			Alabama		
1946	1830.6	$ 7.00	$ 6.40	$21.15	30.1
1947	1926.0	8.02	7.72	28.10	27.4
1948	1937.2	9.58	9.27	36.52	25.4
1949	1895.8	10.75	10.22	35.79	28.5
			Illinois		
1946	1830.6	$10.20	$ 9.35	$25.17	37.3
1947	1926.0	12.95	12.44	30.97	40.1
1948	1937.2	14.80	14.52	35.72	40.7
1949	1895.8	16.35	15.54	41.69	37.4
			Indiana		
1946	1830.6	$ 8.92	$ 8.18	$25.46	32.7
1947	1926.0	13.39	12.87	30.57	42.0
1948	1937.2	14.60	14.11	37.86	37.3
1949	1895.8	16.26	15.45	41.26	37.4
			New York		
1946	1830.6	$ 8.79	$ 8.05	$22.82	35.2
1947	1926.0	10.34	9.95	27.54	36.2
1948	1937.2	12.79	12.39	32.70	37.8
1949	1895.8	13.37	12.68	43.81	28.9
			Ohio		
1946	1830.6	$ 8.21	$ 7.42	$25.00	29.7
1947	1926.0	9.83	9.44	30.87	30.6
1948	1937.2	12.20	11.80	37.98	31.1
1949	1895.8	12.51	11.87	40.92	29.0
			Pennsylvania		
1946	1830.6	$ 7.05	$ 6.45	$24.70	26.1
1947	1926.0	10.04	9.68	30.23	32.0
1948	1937.2	11.40	11.04	36.68	30.1
1949	1895.8	12.18	11.57	43.03	26.9

Table 21

Fuels Used in Steel Works and Rolling Mills, 1947

	Quantity	*Converted into M kw-hr*	*Percent*	*Cost in thousands*	*Unit cost*	*% of total cost*
Bituminous coal, M tons	8 482	13 316 740	11.3	$42 700	$3.21	10.2
Anthracite, M tons	347	544 790	0.4	1 883	3.46	0.4
Coke, M tons	1 485	1 885 950	1.6	9 973	5.30	2.4
Oils, M barrels	50 138	17 698 714	15.1	148 220	8.36	35.3
Natural gas, mill. cu ft	74 566	4 730 467	4.0	21 242	4.48	5.0
Manufactured gas, mill. cu ft	977 488	27 682 177	23.5	35 552	1.28	8.5
Mixed gas, mill. cu ft	1 307 806	37 037 066	31.2	67 293	1.86	16.0
Electric power, mill. kw-hr	9 956	9 956 000	8.5	74 581	7.50	17.8
Other	.....	5 148 096[a]	4.4	18 547	3.62	4.4
Totals		118 000 000		419 991	3.56	

[a] Calculated.

Bituminous coal is used in only small quantities; anthracite and coke use are both negligible. Interest centers on the gaseous and liquid fuels, of which manufactured gas is the most important. The reporting of a large part of the gaseous fuel used by the steel industry as mixed gas makes it impossible to arrive at a total of natural-gas purchase by the industry. The cost of a unit of mixed gas when compared with either natural gas or manufactured gas would seem to indicate that manufactured gas comprises the larger fraction of the fuel group which is segregated under the title "mixed gas."

13. Fuel Costs in the Steel Industry

An examination of fuel costs in the steel industry permits some significant comparisons. In Table 22 an attempt is made to determine the relationship, if such exists, between fuel costs and the quantity used by the industry. For the states listed in the table the cost per unit of fuel and the percentage of fuels used is as shown.

Some inter-fuel competition is apparent. In New York the cost of coal is high and that of fuel oil is medium; the latter supplies 35 percent of the fuel requirements. In Pennsylvania and Ohio a low coal price is accompanied by a relatively high use of this fuel. In Indiana and Illinois, fuel oil is available at low cost from nearby refineries; the percentage of fuel oil used is high. West Virginia, with an abundance of coal readily available at low cost, uses this fuel in high percentage.

Tables 23–26 throw light on the effect of local concentrations of fuel production upon variation in fuel use by types. Table 23 gives the quantities of fuels used in major geographic divisions; Table 24 converts these quantities into kw-hr equivalents, permitting calculation of the contribution made by each type of fuel to the fuel requirements of each geographic division. Table 25 shows fuel distribution for important metropolitan areas, and Table 26, the variation in fuel requirements per worker among metropolitan areas.

Table 22

Comparative Fuel Costs in the Iron and Steel Industry, for Leading States[a]

State	Coal		Fuel oil		Natural gas		Manufactured gas		Mixed gas	
	Cost per ton	*% of total*	*Cost per bbl*	*% of total*	*Cost per mill. cu ft*	*% of total*	*Cost per mill. cu ft*	*% of total*	*Cost per mill. cu ft*	*% of total*
New York	$7.36	5.6	$3.11	35.0	$419.7	0.5	$37.4	16.7	$529.5	2.3
Pennsylvania	4.88	17.9	3.29	28.1	326.0	7.3	33.8	8.3	45.3	5.7
Ohio	5.22	12.2	3.35	36.4	384.0	5.0	39.7	1.6	44.9	20.0
Indiana	6.15	9.0	2.60	45.4	363.0	...	43.6	30.4	332.1	3.6
Illinois	4.40	5.7	2.76	41.3	135.5	4.7	77.4	4.6	26.9	17.1
West Virginia	3.14	22.6	2.88	16.5	316.5	4.6	....	....	72.8	42.7
Alabama	6.14	11.0	3.24	18.0	111.5	2.4	86.0	1.2	122.3	35.7

[a] The table includes only those fuels used in the iron and steel industry which are competitive. Coke and electric power—for both of which no substitution is possible—are omitted.

Table 23

Fuels and Power Used, by Geographic Divisions, 1947

Division	*Bituminous coal, M tons*	*Anthracite, M tons*	*Coke, M tons*	*Fuel oil, M bbl*	*Natural gas, mill. cu ft*	*Manufactured gas, mill. cu ft*	*Mixed gas, mill. cu ft*	*Purchased electric power, mill. kw-hr*
New England	5 651	281	388	21 783	.....	7 549	.....	6 090
Middle Atlantic	26 522	5 153	23 577	47 481	75 277	504 408	507 199	24 319
East N. Central	43 599	810	27 279	50 232	141 812	523 730	730 792	26 301
West N. Central	5 685	170	819	5 362	103 129	35 604	2 698	4 400
South Atlantic	13 816	423	4 956	16 344	54 395	185 574	92 802	11 357
East S. Central	5 945	107	6 263	3 234	57 510	8 881	45 524	10 514
West S. Central	246	96	329	2 197	593 266	505	.....	4 988
Mountain	1 738	26	1 999	2 284	51 289	58 659	11 073	2 279
Pacific	574	12	561	18 030	161 633	4 705	28 791	12 574

Table 24

Fuel Consumption, by Geographic Divisions — Converted into Millions of Kilowatt-hour Equivalent

Division	*Bituminous coal*	*Anthracite*	*Coke*	*Fuel oils*	*Natural gas*	*Manufactured gas*	*Mixed gas*	*Other fuels*[a]	*Purchased electric power*	*Total*
New England										
Kilowatt hours equivalent	8 872	446	493	7 689		728		438	6 090	24 756
Percentage distribution	35.9	1.7	2.0	31.3		2.8		1.8	24.5	100.0
Middle Atlantic										
Kilowatt hours equivalent	41 639	8 090	29 943	16 781	4 776	14 285	14 364	3 392	24 319	157 587
Percentage distribution	26.4	5.0	17.9	11.7	3.1	9.0	9.1	2.2	15.6	100.0
East North Central										
Kilowatt hours equivalent	68 450	1 282	34 644	17 732	8 997	14 832	20 696	3 666	26 301	196 600
Percentage distribution	34.8	0.6	17.7	8.9	5.0	7.2	10.7	1.9	13.3	100.0
West North Central										
Kilowatt hours equivalent	8 925	267	1 040	1 893	6 543	928	76	722	4 400	24 795
Percentage distribution	35.9	1.2	4.2	7.6	25.6	4.9	0.3	2.6	17.7	100.0
South Atlantic										
Kilowatt hours equivalent	21 691	664	6 294	5 769	3 451	5 155	2 628	2 490	11 357	59 400
Percentage distribution	36.6	1.0	10.2	9.8	5.8	8.6	4.3	4.2	19.1	100.0
East South Central										
Kilowatt hours equivalent	9 348	170	7 954	1 142	3 648	252	1 289	1 560	10 514	36 875
Percentage distribution	26.0	0.4	22.1	3.3	10.0	0.7	3.7	4.4	29.4	100.0
West South Central										
Kilowatt hours equivalent	386	151	418	776	37 637	14		3 119	4 988	47 400
Percentage distribution	0.8	0.3	0.9	1.6	79.4			6.8	10.2	100.0
Mountain										
Kilowatt hours equivalent	2 729	41	2 539	806	3 254	1 661	314	613	2 279	14 235
Percentage distribution	19.2	0.2	17.9	5.7	22.7	11.8	2.1	4.4	16.0	100.0
Pacific										
Kilowatt hours equivalent	901	7	712	6 359	10 254	133	815	2 476	12 574	34 200
Percentage distribution	2.5	0.1	2.0	18.6	29.9	0.4	2.5	7.4	36.6	100.0

[a] Calculated.

Table 25

Fuels and Power Consumption in Selected Metropolitan Areas — Converted into Millions of Kilowatt-hour Equivalent

Area	*Bituminous coal*	*Anthracite*	*Coke*	*Fuel oils*	*Natural gas*	*Manufactured gas*	*Mixed gas*	*Purchased electric power*	*Total*
Buffalo	2 780	228	4 885	1 754	50	3 927	41	5 598	19 263
Chicago	9 429	230	14 259	6 443	807	9 522	6 094	4 859	51 549
Cincinnati	1 679	68	39	316	53	....	82	509	2 746
Cleveland	2 960	91	3 192	1 098	534	18	3 195	1 662	12 750
Detroit	6 624	58	2 382	1 957	624	1 963	1 709	3 532	18 859
Los Angeles	4	7	79	1 002	4 011	8	63	2 205	7 379
New York—North Eastern N. J.	4 171	2 476	281	5 716	2	373	1	4 200	17 220
Peoria	1 992	2	29	98	175	0	1	256	2 553
Philadelphia	4 144	543	572	3 225	23	329	16	2 813	11 665
Pittsburgh	10 005	140	16 707	1 387	3 253	2 307	1 334	3 536	38 669
St. Louis	4 320	67	528	587	1 768	206	62	1 244	8 782
Youngstown	2 665	7	8 193	2 287	470	927	4 006	1 406	19 961
	Percentage Distribution of Fuel and Power Consumption, by Types of Fuels								
Buffalo	14.4	1.2	25.3	9.1	0.3	20.3	0.2	29.2	
Chicago	18.3	0.4	27.7	12.4	1.5	18.6	11.9	9.2	
Cincinnati	61.2	2.2	1.1	12.1	1.9	...	3.0	18.6	
Cleveland	23.2	0.8	24.9	8.7	4.2	0.1	25.0	13.1	
Detroit	35.1	0.3	12.7	10.3	3.3	10.4	9.3	18.6	
Los Angeles	....	0.1	1.1	13.6	54.4	0.1	0.8	29.9	
New York—North Eastern N. J.	24.2	14.3	1.6	33.2	...	2.2	...	24.5	
Peoria	77.9	...	1.1	4.0	6.8	...	...	10.2	
Philadelphia	35.5	4.7	4.9	27.7	0.2	2.9	0.1	24.0	
Pittsburgh	25.9	0.3	43.2	3.4	8.4	6.2	3.4	9.2	
St. Louis	49.2	0.8	6.0	6.6	20.3	2.3	0.4	14.4	
Youngstown	13.3	...	40.8	11.4	2.5	4.6	20.1	7.3	

Table 26

Fuels and Power per Production Worker in Selected Metropolitan Areas

Area	*Kw-hr equivalent used, in millions*	*No. of production workers*	*Fuel and power consumption per worker, kw-hr*
Buffalo	19 263	149 758	128 600
Chicago	51 549	756 115	68 000
Cincinnati	2 746	108 476	25 300
Cleveland	12 750	218 929	53 650
Detroit	18 859	466 922	40 400
Los Angeles	7 379	281 806	26 200
New York—North Eastern N. J.	17 220	1 274 357	13 500
Peoria	2 553	34 492	74 000
Philadelphia	11 665	437 553	26 600
Pittsburgh	38 669	284 017	136 000
St. Louis	8 782	200 123	43 880
Youngstown	19 961	94 263	211 700