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Fuels and Power in Manufacturing Industries

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DIVISION OF THE
ILLINOIS STATE GEOLOGICAL SURVEY
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CIRCULAR 259

1958

Circular 259

CORRECTIONS

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4th item should be corrected to read:

	1947	1954	Percent increase
Value added by manufacture, thousands of dollars	\$74,290,475	\$116,912,256	57.2

5th item:

Quantity of fuels used, billion Btu's	7,280,203		6.0
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FUELS AND POWER IN MANUFACTURING INDUSTRIES

W. H. Voskuil

ABSTRACT

This study compares the quantities and costs of each of the fuels used in manufacturing in 1947 and 1954, according to reports by the Bureau of the Census, which classified the industries into 20 manufacturing groups. Thermal value of each fuel is converted into Btu's and costs are computed in cents per million Btu's for each fuel. Changes in the cost of each fuel and in the quantity and cost per worker are reported for each manufacturing group. The cost of fuel is compared with wages paid in the industry, and changes in the ratio of fuel costs to wage costs are also reported for each industry.

The trend of fuel and power consumption per worker in each of the industry groups was almost invariably upward from 1947 to 1954. Natural gas, in most instances, has been the lowest cost fuel but showed a greater percentage increase than either coal or oil. Coke is highest priced, and fuel oil is second highest. Fuel consumption per worker is largest in the metal smelting, fuel processing, chemical, and ceramic industries. It is low in the textile and apparel group and in metal fabricating industries.

Consumption of electrical energy, quantities purchased from utilities, quantities generated by industry, and consumption of electric power in 1947 and 1954 is reported.

FUELS AND ELECTRIC POWER IN MANUFACTURING

Coal, coke, oil, natural gas, and manufactured gas are the fuels used by manufacturing industries. Inasmuch as most manufacturers can use any one of the several types of fuel available, they are interested in knowing how the fuels compare in cost, how much of each is used, and how important their cost is in manufacturing processes.

A detailed report of fuels and electric power used in manufacturing was made by the Bureau of the Census in 1947 and again in 1954. The two reports, together with data from the Census of Manufactures on employment and value of output of manufactures, form the basis of this report.

The census data available for 1947 and 1954 permit a comparison of changes in quantities and costs of each of the fuels used, the quantities of fuels and power used per worker in each industry or industry group, the quantities of electricity used in each type of manufacturing industry, and a comparison of wage costs with fuel and power costs (table 1).

ILLINOIS STATE GEOLOGICAL SURVEY

Table 1. - Economic Changes in Manufacturing
1947 and 1954

	1947	1954	Percent increase
Gross national product, billions of dollars	\$233.3	\$360.7	35.3
Persons employed, thousands	14,294	15,651	8.0
Wages and salaries, thousands of dollars	\$39,689,527	\$62,993,321	59.1
Value added by manufacture, thousands of dollars	\$94,425,825	\$12,373,030	57.5
Quantity of fuels used, billion Btu's	7,201,203	7,702,217	7.0
Value of fuel and purchased electric power, thousands of dollars	\$3,331,518	\$4,924,729	47.7
Purchased electric power, million KW hrs.	102,822	187,027	81.0
Purchased electric power, value, thousands of dollars	\$954,717	\$1,725,350	81.1
Electric power produced, million KW hrs.	43,936	69,683	69.3
Electric power used, million KW hrs.	140,947	247,666	77.0
Fuel used per worker, million Btu's	504	492	-
Kilowatt hours of electricity used per worker	9,860	16,107	63.4

Table 2. - Changes in Fuel Consumption

	1947	1954
Coal, thousands of tons ^a	110,869	91,457
Coal, cost, thousands of dollars	\$692,827	\$676,804
Coke, thousands of tons	66,171	54,371
Coke, cost, thousands of dollars	\$729,403	\$867,865
Fuel oils, thousands of bbls.	166,947	185,541
Fuel oils, cost, thousands of dollars	\$474,945	\$578,220
Natural gas, millions of cubic feet	1,238,311 . . .	5,914,855 ^b
Natural gas, cost, thousands of dollars	\$210,637	
Manufactured gas, millions of cubic feet	1,347,763 . . .	5,914,855 ^b
Manufactured gas, cost, thousands of dollars	\$82,921	
Mixed gas, millions of cubic feet	1,418,879 . . .	\$847,268 ^c
Mixed gas, cost, thousands of dollars	\$89,611	

a Includes anthracite.

b Millions of cubic feet, all gases.

c Cost of all gases.

Table 3. - Contribution of Each Fuel Type^{a,b}
(in billion Btu's)

Fuel	1947			1954		
	Btu equivalent billion	Percent	Cost cents per million Btu's	Btu equivalent billion	Percent	Cost cents per million Btu's
Coal	2,904,768	39.9	24	2,397,614	31.1	28
Coke	1,720,446	23.7	42	1,414,270	18.4	61
Fuel oil	1,001,682	14.1	47	1,118,688	14.5	52
Natural gas	1,238,311	16.1	17	} 2,771,645	36.0	31
Manufactured gas	202,164	2.8	41			
Mixed gas	212,832	2.8	42			
Total	7,280,203	100.0		7,702,217	100.0	

a See table 33 for conversion factors.

b Data from the Census of Manufactures, 1947 and 1954.

Table 4. - Fuel and Power and the Worker

	1947	1954
Number of workers, thousands	14,294	15,651
Salaries and wages paid, thousands of dollars	\$39,689,527	\$62,993,321
Cost of fuel and power, thousands of dollars	\$3,331,518	\$4,924,729
Fuel and power cost - percent of wages	8.4	7.8
Cost of fuel and power per worker	\$233.07	\$314.66

Fuels Consumed

The period 1947 to 1954 has shown differential changes in the quantity and value of fuels used (table 2). Fuel oil and natural gas have both increased in amounts used but coal has decreased. Coke, which does not compete with the other fuels, followed the trend of pig iron production.

Table 3 shows each fuel converted into Btu equivalents in order to compare them easily.

Fuel and Electric Power and the Worker

Workers in manufacturing industries in the United States probably use more fuel and electric power than workers in other important industrial nations. The trend is toward making more fuel and power available to the worker. Reports of the Census of Manufactures for 1947 and 1954 provide the data in sufficient detail to present a statistical record of this trend.

Cost of fuel and electric power has risen less rapidly than salaries and wages. Trends are summarized in table 4.

Fuel and Power Consumption by Manufacturing Groups, 1947 and 1954

In its detailed examination of fuels and power used in manufacturing, the census classifies more than 450 individual manufacturing industries into 20 manufacturing groups.

The distribution of fuel among the 20 manufacturing groups is shown in table 5 which features the heavy fuel requirements of the iron and steel and the nonferrous primary metal industries. In the aggregate, five predominantly heat-processing industries (nos. 26, 28, 29, 32, and 33) use three-fourths of all fuels used in manufacturing.

Fuels and Power and the Worker, 20 Industrial Groups

Fuels and power used by the worker vary among the 20 industrial groups. Also, the ratio of fuel to electric power varies with the nature of the industry. Process industries, generally, consume more fuel than fabricating industries.

All industry groups have shown an increase in both fuel and electric power used per worker in the interval between 1947 and 1954 (table 6).

Salaries and Wages Compared with Cost of Fuel and Power

Table 7 shows two items in the cost of manufacturing - salaries and wages, fuel and power costs - and the ratio between them. Inspection of the table shows

Table 5. - Fuels and Electric Power Used by Manufacturing Groups

	1947		1954		1947		1954	
	Fuel Billion Btu's	Percent of total	Fuel Billion Btu's	Percent of total	Elec. power Million KW hrs.	Percent of total	Elec. power Million KW hrs.	Percent of total
20 Food and kindred products	555,926	7.64	676,780	8.99	10,180	7.72	12,962	5.21
21 Tobacco manufactures	13,587	0.19	9,310	0.12	219	0.16	330	0.13
22 Textile mill products	247,251	3.40	220,626	2.86	10,001	7.10	12,205	4.91
23 Apparel and related products	22,717	0.31	1,929	0.025	850	0.60	1,187	.49
24 Lumber and wood products	45,654	0.63	67,234	0.87	2,338	1.66	4,269	1.72
25 Furniture and fixtures	31,573	0.43	94,987	1.23	826	0.59	1,216	0.49
26 Pulp, paper, and products	530,695	7.29	581,134	7.55	15,386	10.92	23,539	9.47
27 Printing and publishing	19,402	0.27	4,604	0.06	1,280	0.91	1,685	0.68
28 Chemicals and products	810,174	11.13	1,139,113	14.79	19,610	13.91	61,374	24.69
29 Petroleum and coal products	547,062	7.51	720,523	9.35	6,498	4.61	10,575	4.25
30 Rubber products	90,996	1.25	82,120	1.07	3,445	2.44	3,749	1.51
31 Leather and leather products	37,051	0.51	26,631	0.35	573	0.41	731	0.29
32 Stone, clay, and glass products	769,153	10.56	554,026	7.19	7,898	5.60	11,573	4.66
33 Primary metal products	2,922,130	40.14	2,856,790	37.09	40,645	28.84	70,028	28.17
34 Fabricated metal products	125,417	1.72	142,099	1.84	3,901	2.77	5,854	2.36
35 Machinery, except electrical	191,684	2.63	200,899	2.61	5,921	4.20	8,059	3.24
36 Electrical machinery	81,074	1.11	81,079	1.05	3,616	2.57	5,604	2.25
37 Transportation equipment	185,035	2.54	201,495	2.62	6,061	4.30	7,945	3.20
38 Instruments and related products	14,321	0.20	24,191	0.31	545	0.39	994	0.40
39 Miscellaneous manufacturers	39,302	0.54	83,512	1.08	1,114	0.79	4,677	1.88
Total	7,280,203	100.00	7,702,217	100.00	140,947	100.00	248,556	100.00

FUELS AND POWER

Table 6. - Fuel and Power Used per Worker by Industry Groups

	1947 Million Btu's per worker	1954 Million Btu's per worker	Percent change	1947 KW hrs. per worker	1954 KW hrs. per worker	Percent change
20 Food and kindred products	386	428	10.9	7,043	8,190	16.1
21 Tobacco manufactures	125	105	-16.0	1,959	3,480	77.6
22 Textile mill products	200	212	6.0	8,140	11,877	45.9
23 Apparel and related products	21	*	-	762	1,021	33.9
24 Lumber and wood products	72	102	41.6	3,678	6,609	79.7
25 Furniture and fixtures	100	80	-20.0	2,872	3,570	24.3
26 Pulp, paper, and products	1,179	1,096	-7.0	34,204	44,396	29.8
27 Printing and publishing	27	*	-	1,789	2,095	17.1
28 Chemicals and products	1,281	1,540	20.2	31,013	83,009	167.7
29 Petroleum and coal products	2,575	3,336	29.5	30,651	48,994	59.8
30 Rubber products	352	333	-5.3	13,296	15,207	14.4
31 Leather and leather products	98	73	-25.5	1,235	2,050	66.0
32 Stone, clay, and glass products	1,664	1,126	-32.3	17,093	23,531	37.6
33 Primary metal products	2,525	2,558	1.3	35,126	62,690	78.5
34 Fabricated metal products	130	140	7.7	4,016	5,785	44.0
35 Machinery, except electrical	125	130	4.0	3,832	5,228	36.4
36 Electrical machinery	103	85	-17.4	4,512	5,843	29.5
37 Transportation equipment	157	129	-17.8	5,229	5,102	-2.4
38 Instruments and related products	62	88	41.9	2,349	3,647	55.2
39 Miscellaneous manufactures	85	114	34.1	2,399	6,470	169.7

* Not available.

Table 7. - Cost of Fuel and Power Compared with Salaries and Wages^a
(in thousands)

	1947			1954		
	Salaries and wages	Cost of fuels and electric power	Ratio	Salaries and wages	Cost of fuels and electric power	Ratio
20 Food and kindred products	\$3,789,387	\$ 278,783	7.3	\$6,201,482	\$ 419,089	6.7
21 Tobacco manufactures	205,838	6,036	3.0	259,688	7,173	2.8
22 Textile mill products	2,836,166	166,492	5.9	3,032,481	195,749	6.5
23 Apparel and related products	2,527,499	29,728	1.2	3,201,780	27,106	0.8
24 Lumber and wood products	1,337,612	67,798	5.1	1,923,517	99,232	5.2
25 Furniture and fixtures	824,061	21,568	2.6	1,197,370	30,585	2.6
26 Pulp, paper, and products	1,280,672	198,276	15.5	2,217,418	311,488	14.1
27 Printing and publishing	2,277,263	35,205	1.6	3,625,128	39,993	1.1
28 Chemicals and products	1,910,463	296,604	15.5	3,407,186	621,254	18.3
29 Petroleum and coal products	739,345	96,691	13.1	1,101,812	184,712	16.8
30 Rubber products	783,464	45,912	5.9	1,059,337	56,750	5.4
31 Leather and leather products	873,566	20,718	2.4	1,027,310	24,011	2.3
32 Stone, clay, and glass products	1,210,768	257,748	21.2	1,938,067	369,859	19.1
33 Primary metal products	3,594,548	1,317,136	36.6	5,097,460	1,728,880	33.9
34 Fabricated metal products	2,832,835	111,008	3.9	4,397,326	159,839	3.6
35 Machinery, except electrical	4,804,563	146,971	3.0	7,190,551	217,786	3.0
36 Electrical machinery	2,271,039	64,420	2.3	3,950,989	101,163	2.6
37 Transportation equipment	3,719,583	124,695	3.4	8,295,767	217,896	2.6
38 Instruments and related products	665,347	12,459	1.9	1,200,319	21,796	1.8
39 Miscellaneous manufactures	1,205,508	33,270	2.8	2,835,726	87,727	3.1
Total	\$39,689,527	\$3,331,518	8.3	\$63,160,714	\$4,921,795	7.8

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^a Bureau of the Census

that high fuel and power costs are concentrated in five industry groups that are mainly "heat-processing" industries. Important fabricating industries such as manufacture of machinery and transportation equipment have only small fuel and power costs in comparison to salaries and wages.

Fuel and Electric Power Costs

Table 8 indicates in general that the industries increased their expenditures for electric power more than their expenditures for fuel in the interval between 1947 and 1954.

TRENDS OF FUEL CONSUMPTION AND COST IN EACH OF 20 MANUFACTURING GROUPS

Tables 9 through 28 present an analysis of the fuel and power costs and other pertinent economic data for each of the 20 major industrial groups.

In each of the 20 industrial groups, changes have occurred in employment, wages and salaries, kind and quantity of fuels used, cost of fuels, and quantity of electric power used.

In general, the ratio of fuel costs to wages paid has declined from 1947 to 1954. There is a wide difference among industry groups in the quantities of energy used for each man employed.

Industries which require heat in the manufacturing process rank among the highest in fuel consumption. Among those that are very high or higher than the average are food processing, pulp and paper manufacture, chemicals, petroleum refining, glass making, and ferrous and nonferrous smelting industries. The rise of the aluminum reduction industry, in particular, has served to raise the use of electric power.

In the examples listed above, availability of fuel or power at a low or moderate cost is an important factor in locating of industry. This is strikingly true of ferrous blast furnace operation, primary steel manufacture, aluminum reduction, glass manufacture, and some of the chemical industries.

In such industries as tobacco manufacture, textile mill products, apparel, furniture production, printing, and in several of the metal fabricating industries, the cost of fuel and power is a minor element in cost of production, and plant locations are unaffected by fuel costs.

Among the fuels themselves, the cost of gas is on the average lower than the cost of coal or oil, but has increased most rapidly from 1947 to 1954. This is probably accounted for by a decline in the number of industrial-interruptible contracts between gas utilities and industrial fuel consumers. Fuel oil prices are considerably above coal or gas prices, but fuel oil maintains its position in the market because of advantages of fuel in liquid form.

Coke prices are highest because of the high cost of coke manufacture.

Table 8. - Fuel and Power Costs and Purchased Electric Power Costs
(in thousands)

	1947			1954		
	Fuel and power costs	Purchased electric power costs	Percent electric power	Fuel and power costs	Purchased electric power costs	Percent electric power
20 Food and kindred products	\$278,783	\$108,531	38.8	\$419,089	\$168,645	40.2
21 Tobacco manufactures	6,036	2,174	36.0	7,173	3,498	48.7
22 Textile mill products	166,492	82,456	49.5	195,749	144,758	58.8
23 Apparel and related products	29,728	20,567	69.2	27,106	23,538	86.7
24 Lumber and wood products	67,798	19,964	29.4	99,232	41,505	41.8
25 Furniture and fixtures	21,568	11,670	54.1	30,585	18,830	61.6
26 Pulp, paper, and products	198,276	50,606	25.5	311,488	91,452	29.4
27 Printing and publishing	35,205	23,796	67.4	39,993	36,150	90.3
28 Chemicals and products	296,604	85,405	28.8	621,254	286,015	46.0
29 Petroleum and products	96,691	28,293	29.3	184,712	56,052	30.4
30 Rubber products	45,912	24,685	53.8	56,750	32,745	57.6
31 Leather and leather products	20,718	8,888	42.9	24,011	11,859	49.3
32 Stone, clay, and glass products	257,748	54,878	21.4	369,859	95,116	25.7
33 Primary metal products	1,317,136	188,784	14.3	1,728,880	305,346	17.7
34 Fabricated metal products	111,008	53,957	48.6	159,839	86,214	54.0
35 Machinery, except electrical	146,971	71,952	49.0	217,786	107,948	49.5
36 Electrical machinery	64,420	34,578	53.5	101,163	63,259	62.7
37 Transportation equipment	124,695	59,242	47.6	217,896	123,500	56.7
38 Instruments and related products	12,459	6,763	54.3	21,796	11,404	52.2
39 Miscellaneous manufactures	33,270	17,528	53.7	87,727	50,900	57.9

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Table 9. - Food and Kindred Products

Item	1947	1954	Percent change
Number of employees	1,441,847	1,647,204	14.2
Payroll, in thousands of dollars	\$3,789,387	\$6,201,482	63.6
Average payroll	\$2,628	\$3,765	43.3
Fuels used, trillion Btu's:			
Coal	348	293	-15.8
Coke	5	2	-60.0
Fuel oil	92	123	33.6
Gas	112	259	131.2
Total	557	677	21.5
Cost of fuels, thousands of dollars	\$170,252	\$250,433	47.0
Percent, fuels cost of payroll	4.5	4.0	--
Btu's per worker, million	386	411	10.9
KW hours per worker	7,053	8,190	16.1
Fuel costs, cents per million Btu's:			
Coal	23	29	26.1
Coke	54	74	37.0
Fuel oil	48	55	14.6
Gas	21	27	28.6

Table 10. - Tobacco Manufacturers

Item	1947	1954	Percent change
Number of employees	111,782	94,862	-15.1
Payroll, in thousands of dollars	\$205,838	\$259,688	26.2
Average payroll	\$1,841	\$2,737	48.7
Fuels used, trillion Btu's:			
Coal	13	7.0	-46.2
Coke	--	.1	--
Fuel oil	1	2.0	100.0
Gas	--	1.0	--
Total	14	10.1	-28.6
Cost of fuels, thousands of dollars	\$3,862	\$3,684	- 4.6
Percent, fuels cost of payroll	1.9	1.4	--
Btu's per worker, million	125	105	-16.0
KW hours per worker	1,959	3,480	77.6
Fuel costs, cents per million Btu's:			
Coal	26	42	61.5
Coke	--	63	--
Fuel oil	49	52	6.1
Gas	36	45	25.0

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Table 11. - Textile Mill Products

Item	1947	1954	Percent change
Number of employees	1,233,431	1,037,425	-15.9
Payroll, in thousands of dollars	\$2,836,166	\$3,032,481	69.2
Average payroll	\$2,299	\$2,923	27.1
Fuels used, trillion Btu's:			
Coal	173.0	130.0	-24.9
Coke	.5	.5	--
Fuel oil	68.0	67.0	- 1.5
Gas	5.2	23.0	342.3
Total	246.7	220.5	-10.6
Cost of fuels, thousands of dollars	\$84,036	\$80,721	- 3.9
Percent, fuels cost of payroll	3	2.7	--
Btu's per worker, million	200	212	6.0
KW hours per worker	8,140	11,877	45.9
Fuel costs, cents per million Btu's:			
Coal	30	30	--
Coke	53	61	15.1
Fuel oil	44	46	4.5
Gas	21	38	80.9

Table 12. - Apparel and Related Products

Item	1947	1954	Percent change
Number of employees	1,081,844	1,190,064	10.0
Payroll, in thousands of dollars	\$2,527,499	\$3,201,795	26.7
Average payroll	\$2,336	\$2,690	17.9
Fuels used, trillion Btu's:			
Coal	16.0	*	--
Coke	.1	*	--
Fuel oil	4.0	*	--
Gas	2.1	*	--
Total	22.2		
Cost of fuels, thousands of dollars	\$9,161	\$3,568	-61.1
Percent, fuels cost of payroll	.4	.1	--
Btu's per worker, million	21	*	--
KW hours per worker	762	1,021	33.9
Fuel costs, cents per million Btu's:			
Coal	29	*	--
Coke	32	*	--
Fuel oil	58	*	--
Gas	26	*	--

* Not available.

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Table 13. - Lumber and Products, Except Furniture

Item	1947	1954	Percent change
Number of employees	635,708	645,936	1.6
Payroll, in thousands of dollars	\$1,337,612	\$1,933,523	44.6
Average payroll	\$2,104	\$2,978	41.5
Fuels used, trillion Btu's:			
Coal	23.0	22.0	- 4.3
Coke	--	.2	--
Fuel oil	20.0	24.0	20.0
Gas	3.0	20.0	566.7
Total	46.0	66.2	43.9
Cost of fuels, thousands of dollars	\$47,834	\$57,727	20.7
Percent, fuels cost of payroll	3.6	3.0	--
Btu's per worker, million	72	102	41.6
KW hours per worker	3,678	6,609	79.7
Fuel costs, cents per million Btu's:			
Coal	25	36	44.0
Coke	--	68	--
Fuel oil	58	71	22.4
Gas	16	25	56.3

Table 14. - Furniture and Fixtures

Item	1947	1954	Percent change
Number of employees	322,384	340,689	5.7
Payroll, in thousands of dollars	\$824,061	\$1,197,370	45.3
Average payroll	\$2,556	\$3,514	37.5
Fuels used, trillion Btu's:			
Coal	27.0	17.0	-37.0
Coke	.2	.1	-50.0
Fuel oil	3.0	4.0	33.3
Gas	2.2	6.0	172.3
Total	32.4	27.1	-16.4
Cost of fuels, thousands of dollars	\$9,898	\$11,755	18.8
Percent, fuels cost of payroll	1.2	.9	--
Btu's per worker, million	100	80	-20.0
KW hours per worker	2,872	3,570	24.3
Fuel costs, cents per million Btu's:			
Coal	25	33	34.8
Coke	32	82	156.25
Fuel oil	55	69	25.5
Gas	34	37	- 8.8

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Table 15. - Paper and Allied Products

Item	1947	1954	Percent change
Number of employees	449,833	530,204	17.9
Payroll, in thousands of dollars	\$1,280,672	\$2,217,418	73.1
Average payroll	\$2,847	\$4,182	46.9
Fuels used, trillion Btu's:			
Coal	390.0	329.0	-15.6
Coke	.3	.3	--
Fuel oil	71.0	135.0	9.0
Gas	69.3	117.0	6.9
Total	530.6	581.3	9.6
Cost of fuels, thousands of dollars	\$147,670	\$220,036	49.0
Percent, fuels cost of payroll	11.5	9.9	--
Btu's per worker, million	1,179	1,096	- 7.0
KW hours per worker	34,204	44,396	29.8
Fuel costs, cents per million Btu's:			
Coal	27	32	18.5
Coke	32	71	121.9
Fuel oil	39	43	10.3
Gas	12	21	75.0

Table 16. - Printing and Publishing Industries

Item	1947	1954	Percent change
Number of employees	715,450	804,381	12.4
Payroll, in thousands of dollars	\$2,277,263	\$3,625,128	59.2
Average payroll	\$3,183	\$4,507	41.6
Fuels used, trillion Btu's:			
Coal	10.0	*	--
Coke	.1	*	--
Fuel oil	4.0	*	--
Gas	5.6	*	--
Total	19.7		
Cost of fuels, thousands of dollars	\$11,409	\$3,843	-66.3
Percent, fuels cost of payroll	.5	.1	--
Btu's per worker, million	27	*	--
KW hours per worker	1,789	2,095	17.1
Fuel costs, cents per million Btu's:			
Coal	29	*	--
Coke	39	*	--
Fuel oil	53	*	--
Gas	30	*	--

* Not available.

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Table 17. - Chemicals and Allied Products

Item	1947	1954	Percent change
Number of employees	632,319	739,369	16.9
Payroll, in thousands of dollars	\$1,910,463	\$3,407,186	78.3
Average payroll	\$3,021	\$4,608	52.5
Fuels used, trillion Btu's:			
Coal	497	550	10.7
Coke	55	1	-98.2
Fuel oil	100	106	6.0
Gas	158	482	205.1
Total	810	1,139	4.1
Cost of fuels, thousands of dollars	\$211,199	\$335,293	58.8
Percent, fuels cost of payroll	11.1	9.8	--
Btu's per worker, million	1,281	1,540	20.2
KW hours per worker	31,013	83,009	167.7
Fuel costs, cents per million Btu's:			
Coal	23	26	13.0
Coke	44	39	-11.4
Fuel oil	44	47	6.8
Gas	14	27	92.8

Table 18. - Petroleum and Coal Products

Item	1947	1954	Percent change
Number of employees	212,003	215,840	1.8
Payroll, in thousands of dollars	\$739,345	\$1,101,812	49.0
Average payroll	\$3,487	\$5,105	46.4
Fuels used, trillion Btu's:			
Coal	67	37	-44.8
Coke	1	2	100.0
Fuel oil	22	25	13.6
Gas	456	656	43.9
Total	546	720	31.9
Cost of fuels, thousands of dollars	\$68,398	\$128,660	88.1
Percent, fuels cost of payroll	.9	11.7	--
Btu's per worker, million	2,575	3,336	29.5
KW hours per worker	30,651	48,994	59.8
Fuel costs, cents per million Btu's:			
Coal	20	23	15.0
Coke	12	21	75.0
Fuel oil	42	43	2.4
Gas	9	16	77.8

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Table 19. - Rubber Products

Item	1947	1954	Percent change
Number of employees	259,092	246,526	- 4.8
Payroll, in thousands of dollars	\$783,464	\$1,059,337	35.2
Average payroll	\$3,023	\$4,297	42.1
Fuels used, trillion Btu's:			
Coal	74.0	58.0	-21.6
Coke	.1	.0	-100.0
Fuel oil	9.0	12.0	33.3
Gas	8.0	12.0	50.0
Total	91.1	82.0	- 9.9
Cost of fuels, thousands of dollars.	\$21,227	\$24,005	13.1
Percent, fuels cost of payroll	2.7	2.3	--
Btu's, per worker, million	352	333	- 5.3
KW hours per worker	13,296	15,207	14.4
Fuel costs, cents per million Btu's:			
Coal	21	25	19.0
Coke	37	58	56.7
Fuel oil	41	46	12.2
Gas	19	30	57.9

Table 20. - Leather and Leather Products

Item	1947	1954	Percent change
Number of employees	383,175	356,574	- 6.9
Payroll, in thousands of dollars	\$873,566	\$1,027,310	17.6
Average payroll	\$2,279	\$2,881	26.4
Fuels used, trillion Btu's:			
Coal	32.0	16.0	-50.0
Coke	.1	.0	-100.0
Fuel oil	5.0	7.0	40.0
Gas	.4	3.0	65.0
Total	37.5	26.0	-30.7
Cost of fuels, thousands of dollars	\$11,830	\$12,152	2.7
Percent, fuels cost of payroll	1.4	1.2	--
Btu's per worker, million	98	73	-25.5
KW hours per worker	1,235	2,050	66.0
Fuel costs, cents per million Btu's:			
Coal	28	41	46.4
Coke	45	--	--
Fuel oil	50	53	6.0
Gas	29	37	27.6

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Table 21. - Stone, Clay, and Glass Products

Item	1947	1954	Percent change
Number of employees	462,072	491,803	6.4
Payroll, in thousands of dollars	\$1,210,768	\$1,938,067	60.1
Average payroll	\$2,620	\$3,941	50.4
Fuels used, trillion Btu's:			
Coal	445	357	-19.8
Coke	10	5	-50.0
Fuel oil	88	94	6.8
Gas	226	98	-56.6
Total	769	554	-27.9
Cost of fuels, thousands of dollars	\$202,870	\$274,743	35.4
Percent, fuels cost of payroll	16.8	14.2	--
Btu's per worker, million	1,664	1,126	-32.3
KW hours per worker	17,093	23,531	37.6
Fuel costs, cents per million Btu's:			
Coal	22	27	22.7
Coke	55	69	25.5
Fuel oil	44	54	22.7
Gas	22	115	422.7

Table 22. - Primary Metal Industries

Item	1947	1954	Percent change
Number of employees	1,157,124	1,117,053	- 3.4
Payroll, in thousands of dollars	\$3,594,548	\$5,097,460	14.8
Average payroll	\$3,106	\$4,563	46.9
Fuels used, trillion Btu's:			
Coal	411	258	-37.2
Coke	1,607	1,384	-13.9
Fuel oil	386	338	-12.4
Gas	518	877	69.3
Total	2,922	2,857	- 2.2
Cost of fuels, thousands of dollars	\$1,128,352	\$1,423,534	26.2
Percent, fuels cost of payroll	31.4	27.9	--
Btu's per worker, million	2,525	2,558	1.3
KW hours per worker	35,126	62,690	78.5
Fuel costs, cents per million Btu's:			
Coal	21	26	23.8
Coke	42	61	45.2
Fuel oil	49	52	6.1
Gas	28	35	25.0

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Table 23. - Fabricated Metal Products

Item	1947	1954	Percent change
Number of employees	971,461	1,011,951	4.9
Payroll, in thousands of dollars	\$2,832,835	\$4,397,326	55.2
Average payroll	\$2,916	\$4,314	47.9
Fuels used, trillion Btu's:			
Coal	60	42	-30.0
Coke	11	4	-63.6
Fuel oil	31	37	19.4
Gas	24	59	145.8
Total	126	142	12.7
Cost of fuels, thousands of dollars	\$57,051	\$73,625	29.1
Percent, fuels cost of payroll	2.0	1.7	--
Btu's per worker, million	130	140	7.7
KW hours per worker	4,016	5,785	44.0
Fuel costs, cents per million Btu's:			
Coal	26	33	26.9
Coke	60	90	50.0
Fuel oil	55	64	16.4
Gas	37	46	24.3

Table 24. - Machinery (Except Electrical)

Item	1947	1954	Percent change
Number of employees	1,545,323	1,541,658	- .2
Payroll, in thousands of dollars	\$4,804,563	\$7,190,551	49.7
Average payroll	\$3,109	\$4,664	50.0
Fuels used, trillion Btu's:			
Coal	110	85	-22.7
Coke	17	9	-47.1
Fuel oil	38	46	21.1
Gas	28	61	117.9
Total	193	201	4.1
Cost of fuels, thousands of dollars	\$75,019	\$109,838	46.4
Percent, fuels cost of payroll	1.6	1.5	--
Btu's per worker, million	125	130	4.0
KW hours per worker	3,832	5,228	36.4
Fuel costs, cents per million Btu's:			
Coal	25	30	20.0
Coke	63	89	41.3
Fuel oil	52	60	15.4
Gas	36	43	19.4

Table 25. - Electrical Machinery

Item	1947	1954	Percent change
Number of employees	801,359	959,119	19.6
Payroll, in thousands of dollars	\$2,271,039	\$3,950,989	73.9
Average payroll	\$2,833	\$4,119	45.4
Fuels used, trillion Btu's:			
Coal	55.0	38.0	-30.9
Coke	5.0	.5	-90.0
Fuel oil	14.0	21.0	50.0
Gas	8.4	22.0	161.9
Total	82.4	81.5	- 1.1
Cost of fuels, thousands of dollars	\$29,842	\$37,904	27.0
Percent, fuels cost of payroll	1.3	1.0	--
Btu's per worker, million	103	85	-17.4
KW hours per worker	4,512	5,843	29.5
Fuel costs, cents per million Btu's:			
Coal	24	34	41.7
Coke	65	89	36.9
Fuel oil	50	54	8.0
Gas	39	47	20.5

Table 26. - Transportation Equipment

Item	1947	1954	Percent change
Number of employees	1,181,680	1,704,572	44.2
Payroll, in thousands of dollars	\$3,719,583	\$8,295,767	123.0
Average payroll	\$3,147	\$4,866	48.2
Fuels used, trillion Btu's:			
Coal	119	110	- 7.6
Coke	9	5	-44.4
Fuel oil	32	40	25.0
Gas	26	46	76.9
Total	186	201	8.1
Cost of fuels, thousands of dollars	\$65,453	\$94,389	44.2
Percent, fuels cost of payroll	1.8	1.1	--
Btu's per worker, million	157	119	-24.2
KW hours per worker	5,229	5,102	- 2.4
Fuel costs, cents per million Btu's:			
Coal	24	29	20.8
Coke	43	88	104.6
Fuel oil	50	60	20.0
Gas	36	45	25.0

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Table 27. - Instruments and Related Products

Item	1947	1954	Percent change
Number of employees	231,997	272,583	17.4
Payroll, in thousands of dollars	\$665,347	\$1,200,319	80.4
Average payroll	\$2,867	\$4,403	53.6
Fuels used, trillion Btu's:			
Coal	10.0	14.0	40.0
Coke	.1	.1	--
Fuel oil	3.0	5.0	66.7
Gas	1.2	5.0	316.7
Total	14.3	24.1	68.5
Cost of fuels, thousands of dollars	\$5,696	\$10,392	82.4
Percent, fuels cost of payroll	.9	.9	--
Btu's per worker, million	62	88	41.9
KW hours per worker	2,349	3,647	55.2
Fuel costs, cents per million Btu's:			
Coal	28	34	21.4
Coke	63	129	104.8
Fuel oil	48	56	16.7
Gas	37	40	8.1

Table 28. - Miscellaneous Manufacturers

Item	1947	1954	Percent change
Number of employees	464,420	695,917	49.8
Payroll, in thousands of dollars	\$1,205,508	\$2,658,182	120.5
Average payroll	\$2,595	\$3,820	47.2
Fuels used, trillion Btu's:			
Coal	25.0	27.0	8.0
Coke	.3	.2	-33.3
Fuel oil	12.0	31.0	158.3
Gas	2.4	24.0	900.0
Total	39.7	82.2	107.1
Cost of fuels, thousands of dollars	\$15,742	\$33,462	133.9
Percent, fuels cost of payroll	1.3	1.2	--
Btu's per worker, million	85	118	34.1
KW hours per worker	2,399	6,470	169.7
Fuel costs, cents per million Btu's:			
Coal	28	32	14.3
Coke	50	74	48.0
Fuel oil	49	53	8.2
Gas	36	37	2.8

Table 29. - Summary of Manufacturing Industries
Electric Power Consumption, 1947 and 1954

Industry group	Electricity used million KW hrs.		Employees		Electricity used per worker, KW hrs.		Percent change
	1947	1954	1947	1954	1947	1954	
20 Food and kindred products	10,180	13,972	1,441,847	1,582,542	7,053	8,190	16.12
21 Tobacco manufactures	219	330	111,982	94,862	1,959	3,480	77.64
22 Textile mill products	10,041	12,322	1,233,431	1,037,425	8,140	11,877	45.91
23 Apparel and related products	824	915	1,081,844	1,163,022	762	1,021	33.99
24 Lumber and products, except furniture	2,338	4,269	635,708	645,928	3,678	6,609	79.69
25 Furniture and fixtures	926	1,216	322,384	340,689	2,872	3,570	24.30
26 Paper and allied products	15,386	23,539	449,833	530,204	34,204	44,396	29.80
27 Printing and publishing industries	1,280	1,685	715,450	804,381	1,789	2,095	17.10
28 Chemicals and allied products	19,610	61,166	632,319	739,369	31,013	83,009	167.66
29 Petroleum and coal products	6,498	10,579	212,003	215,840	30,651	48,994	59.84
30 Rubber products	3,445	3,749	259,092	246,526	13,296	15,207	14.37
31 Leather and leather products	573	731	383,175	356,574	1,235	2,050	65.99
32 Stone, clay, and glass products	7,898	11,573	462,072	491,803	17,093	23,531	37.66
33 Primary metal industries	40,645	65,935	1,157,124	1,117,053	35,126	62,690	78.47
34 Fabricated metal products	3,901	5,812	971,461	1,011,951	4,016	5,785	44.05
35 Machinery, except electrical	5,921	8,059	1,545,323	1,541,658	3,832	5,228	36.43
36 Electrical machinery	3,616	5,604	801,359	959,119	4,512	5,843	29.50
37 Transportation equipment	6,061	11,804	1,181,680	1,557,325	5,229	5,102	- 2.4
38 Instruments and related products	545	994	231,997	272,583	2,349	3,647	55.26
39 Miscellaneous manufactures	1,114	3,479	464,420	722,845	2,399	6,470	169.7
Total	140,421	248,556	14,294,304	15,431,899	9,824 ^a	16,107 ^a	63.96 ^a

a Average.

ELECTRICITY IN MANUFACTURING

A detailed report of electric power used by each manufacturing industry was made by the Bureau of the Census in 1947 and again in 1954. (Electricity "used" in manufacturing industries is calculated as purchased energy plus energy generated less energy sold.) The manufacturing industries obtain electric power for use in manufacturing partly by purchase from public utilities and partly by generating additional power.

Use of electric power and requirements per worker vary with individual manufacturing industries and groups. Approximately 460 manufacturing industries are divided into 20 groups, each of which represents a number of more or less closely related industries.

Manufacturing industries increased their use of electric power 64 percent for each person employed in the interval between 1947 and 1954. The average quantity of electric power used per worker rose from 9,924 KW hours in 1947 to 16,107 KW hours in 1954. The average conceals wide disparities in the quantities of electricity used per worker among the 20 groups of manufacturing industries as classified by the census. The largest users of electric power are paper and allied products, chemicals, petroleum and coal products, stone, clay and glass, and primary metal industries (table 29).

Group Analysis

Several of the industry groups show a high rate of increase. For instance, tobacco manufactures increased their use of electricity 78 percent, lumber 80 percent, chemicals 168 percent, petroleum and coal products 60 percent, leather and leather products 66 percent, primary metals 78 percent, and instruments 55 percent.

On the other hand, food products, printing and publishing, and rubber products showed relatively small increases. Transportation equipment used less electric power per worker in 1954 as compared with that used in 1947.

A group-by-group analysis of industries showing the greatest increase in electric power consumption reveals some interesting sidelights. In tobacco manufacture, electric power consumption is small but, nevertheless, consumption showed an increase per worker of 78 percent in the interval from 1947 to 1954. This may be due to a greater degree of mechanization in cigarette manufacture and also to a greater change in output of cigarettes compared with cigars and smoking tobacco. For example, cigarette output increased 14 percent and cigars 9.5 percent, but the output of smoking and chewing tobacco decreased 18 percent.

Lumber

Sawmills and planing mills account for the greatest increase in use of electric power by lumber industries. This classification used 2,810 million KW hours out of a total of 4,269 million KW hours or 65.8 percent. The use of electric power by sawmills and planing mills increased from 3,714 KW hours per employee to 8,748 KW hours, or an increase of 135.5 percent between 1947 and 1954.

Table 30. - Chemical Industry Summarized

Industry no.	Electric power used (million KW hrs.)		Workers		KW hrs. used per worker	
	1947	1954	1947	1954	1947	1954
	2819 ^a	4,623	34,928	45,494	97,006	101,618
2829 ^a	5,379	7,181	85,015	67,531	63,271	106,336
39 other groups	9,608	19,265	501,810	574,832	19,146	33,514
All chemical groups	19,810	61,374	632,319	739,369	31,013	83,009

a Among the 41 subdivisions of the chemical industry classified by the census, two inorganic chemicals (not elsewhere specified) and organic chemicals (not elsewhere specified) account for a large portion of the electric power used in this industry.

Chemicals

The group of 46 separate chemical industries increased their consumption of electric power from 31,013 KW hours per worker to 83,009 KW hours, a jump of 168 percent for the entire group of chemical industries (table 30).

Two of the groups, inorganic chemicals and organic chemicals not elsewhere classified, account for major quantities of electric power consumption and also major increases in power use by workers.

Electric power in the inorganic chemical group rose from 101,618 KW hours per worker to 360,060 KW hours per worker, an increase of 254.33 percent. In the organic chemical group, the consumption increased from 63,271 KW hours per worker to 106,336 KW hours, an increase of 68.06 percent.

The remaining 44 subdivisions of chemical manufactures averaged 19,146 KW hours per worker in 1947 and 33,514 KW hours in 1954, an increase of 75.04 percent.

Petroleum refining and byproduct coke manufacture together showed an increase of about 60 percent.

Metallurgical Industries

The metallurgical industries group is the largest user of electric power among the 20 manufacturing groups classified by the census. The group comprises ferrous metals, primary and secondary nonferrous metals, nonferrous metal rolling and drawing, foundries, and miscellaneous types of industries. It accounts for 28 percent of the total electric power used and its per capita consumption is exceeded only by the chemical groups.

The general average of electric power consumption in the metallurgical group rose from 35,126 KW hours per person to 62,690 KW hours per person.

The aluminum industry is the largest consumer of KW hours of electric power per person as indicated in table 31.

Ferrous electrometallurgical products followed aluminum reduction as a user of electric power per worker. Other large users were primary zinc smelting, primary copper, and steel plants and rolling mills.

Table 31. - Summary of Primary Metal Industries
Electric Power Consumption, 1947 and 1954

No.	Group	Electricity used million KW hrs.		Employees		Electricity used per worker, KW hrs.		Percent change
		1947	1954	1947	1954	1947	1954	
11-12	Blast furnaces, steel works, and rolling mills	16,813	25,575	537,736	518,690	31,266	49,307	57.7
13	Electrometallurgical products	4,903	5,928	9,628	11,361	509,244	521,785	2.5
21	Gray-iron foundries	966	1,090	173,776	133,914	5,559	8,140	46.4
22	Malleable-iron foundries	236	273	29,862	23,378	7,903	11,677	47.8
23	Steel foundries	1,062	1,180	63,668	55,073	16,680	21,426	28.5
31	Primary copper	738	746	14,629	13,818	50,448	53,988	7.0
32	Primary lead	141	136	4,663	4,063	30,238	33,473	10.7
33	Primary zinc	1,412 ^a	1,686	12,424	10,470	113,651	161,032	41.7
34	Primary aluminum	10,331 ^a	26,283	8,919	20,626	1,158,314	1,274,266	10.0
39	Primary nonferrous metals, n.e.c.	32	1,581	2,169	5,519		286,465	
41	Secondary nonferrous metals	156	185	18,402	15,775	8,477	11,727	38.3
51	Copper rolling and drawing	987	1,028	53,867	41,906	18,323	24,531	33.9
52	Aluminum rolling and drawing	970	1,385	27,365	36,803	35,447	37,633	6.2
59	Nonferrous metal rolling, n.e.c.	132	224	7,592	10,381	17,387	21,578	24.1
61	Nonferrous foundries	295	586	65,342	73,487	4,514	7,974	76.1
91	Iron and steel forgings	296	497	36,724	39,771	8,060	12,496	55.0
92	Wire drawing	714	873	55,079	54,873	12,963	15,909	22.7
93	Welded and heavy-riveted pipe	135	347	13,144	22,085	10,270	15,712	53.0
99	Primary metal industries, n.e.c.	323	425	22,135	25,060	14,592	16,959	16.2
	Total	40,645	70,208	1,157,124	1,117,053	35,126 ^b	62,690 ^b	78.5 ^b

a Calculated.

b Average.

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Table 32. - Electric Power Used in Manufacturing
1947 and 1954
(in millions of kilowatt hours)

	1947	1954
Electric power purchased	107,822	186,066
Electric power generated	43,936	74,381
Total	146,758	260,447
Less sales	5,811	8,944
Net total	140,947	251,503

Sources of Electric Power

The manufacturing industries purchase about 70 percent of all electric power used and produce the remainder in their own plants. Purchases of electricity in 1954 totalled 10 billion KW hours, requiring consumption of approximately 90 million tons of coal equivalent. This should be added to the reported fuel consumption in manufacturing industries in order to get a total of fuels needed.

The use of electric power in manufacturing has increased from a net total of 140,947 million KW hours in 1947 to 251,503 million KW hours in 1954 (table 32). This increase in use of electric power is of interest to the electric utility industry; it is of special interest to know where the increases have occurred and what may be the future trends.

FUEL CONVERSION FACTORS

The conversion of fuel values of each kind of fuel to a common factor is a necessary first step in a study of economic competition among the several fuels used in the United States. A general conversion table has been prepared by the U. S. Bureau of Mines that is used for general comparisons (table 33).

The conversion figures have been used in this report in the general tables on fuel used in manufacturing. Manufactured and mixed gas are each valued at 250 Btu's per cubic foot.

In arriving at this average value for manufactured and mixed gases, account is taken of the quantity of average Btu value of each of the processed gases used as fuels in manufacturing; that is, blast furnace gas, coke oven gas, still gas, and public utility manufactured gases. A tabulation of the quantities of these gases used in manufacturing is given for 1947, and this tabulation is used as a basis for arriving at an average Btu value. This is applied to the coal and petroleum industry group and the primary metals group, the two groups in which most of the manufactured and byproduct gases are used.

Table 33. - Conversion Factors

Item	Unit	Btu per unit
Bituminous coal	ton	26,200,000
Anthracite	ton	27,200,000
Crude oil	bbl.	6,000,000
Natural gas:		
Before treatment	cu. ft.	1,075
After treatment	cu. ft.	1,000
Natural gasoline	bbl.	4,620,000
Coke-oven and manufactured gas products:		
Coke	ton	26,000,000
Gas	cu. ft.	Converted to 540
Tar	bbl.	6,300,000
Light oils	bbl.	5,460,000
Refinery products:		
Motor fuel	bbl.	5,250,000
Kerosene	bbl.	5,640,000
Diesel and gas oil	bbl.	5,920,000
Residual fuel oil	bbl.	6,270,000
Coke	bbl.	6,000,000
Lubes	bbl.	6,060,000
Wax	bbl.	5,570,000
Asphalt	bbl.	6,640,000
Road oil	bbl.	6,640,000
Shale:		
Ore	ton	4,000,000
Oil	bbl.	6,000,000
Refinery (still) gas	cu. ft.	1,500

FROM: Bureau of Mines, Information Circular 7582, Energy Uses and Supplies, 1939, 1947, 1965, table 19, p. 32, 1950.

Notes

In calculating the total quantity of fuels (as billion Btu's) used in manufacturing, blast furnace gas must not be counted because it has already been calculated in coke. Coke-oven gas and refinery and still gas are counted because they come from coal and oil fuels used as raw materials in manufacturing and not as fuels for processing other materials into manufactured goods.

Btu Value of Manufactured Gases

The average Btu content of manufactured gas is calculated from the table "Gas Consumed for Fuel in Manufacturing Industries, by Type of Gas," p. 173, in MC203, Census of Manufactures, 1947. A Btu value of 90 per cubic foot was assigned to blast furnace gas and 520 Btu to coke-oven gas. These figures were multiplied by the reported volumes of gas of each kind, summed, and averaged. The result, rounded off, was 250 Btu's.



CIRCULAR 259

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