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The Electric and Gas Utilities in the Nation's Economy

INDUSTRIES, LIKE PERSONS, think of themselves as unique. Keenly aware of the many ways in which they differ from other members of their species, they feel their lives to be special experiences. Scientists view individuals in more matter-of-fact terms. In studying the organization and functioning of the human body, doctors pass over individual eccentricities and seek similarities. Economists have acquired the same custom. Confronted by variation, they strike averages; on scatter diagrams they plot regression lines. In their study of industries they look first for resemblances and uniformities.

This is good sense. If we are to understand individuals, we must see them as members of species. To understand the development of an industry we must view its experience in the light of the experience of other industries.

For this we need a careful description of the development of each industry. Such description is not simple or easy, even if it be limited to certain aspects, as the reader of the following report will find. It means working with heterogeneous, incomplete, and not always consistent data; it demands care and skill. This basic task of description is the job Dr. Gould has assigned himself in his study of production, employment, and productivity in the electric and gas utilities since 1899. It is one that he has accomplished in workmanlike fashion.

The indexes Dr. Gould has compiled tell us a good deal about the growth of the two utilities. They also add to our knowledge of industries in general; they contribute to the study of trends in Ameri-

can industry in which the National Bureau has been engaged for some years.[1] In turn, what we have already learned about the other segments of the economy lends perspective to Dr. Gould's review of the electric and gas utilities. There is value, therefore, in considering how the development of these utilities compares with that of the other industries so far studied, and how the careers of the electric and gas utilities, in the aspects covered, illustrate or depart from general experiences characterizing other industries. In making this comparison, we can summarize for the reader some of the highlights of the story Dr. Gould tells in detail.

The best single measure of an industry's growth is the advance in its physical output. Between the opening of the century and the outbreak of World War II, the output of the electric light and power industry multiplied 40 times. The gas utilities, though less prolific, increased output almost sevenfold. These are big advances, far greater than those characterizing most industries in the same period. Between 1899 and 1939 the output of just a few agricultural products rose comparably; and among them citrus fruits alone attained any great size. In mining, operation of petroleum and natural gas wells is the one important industry with comparable growth; the output of every other rapidly growing mineral, such as sulphur, bauxite, and gypsum, was valued at less than $50 million in 1939. Among manufactures, the growth of just two important industries, among those for which we have statistics, namely, automobiles and cigarettes, exceeded that of electric power plants. Surpassing the growth of the gas utilities there were, in addition, such major manufacturing industries as petroleum refining, canned foods, hosiery, cement, silk and rayon goods, paper and printing. But the average increase in the output of manufacturing industries, about 275 percent between 1899 and 1939, still fell short of the increase in gas production. Such dominant factory industries as steel-mill products, cotton goods, meat packing, and lumber, as well as many smaller industries, grew less rapidly than the gas utilities, or actually declined.

[1] Other reports so far published include: *The Output of Manufacturing Industries, 1899–1937*, by Solomon Fabricant, assisted by Julius Shiskin (1940); *Employment in Manufacturing, 1899–1939: An Analysis of its Relation to the Volume of Production*, by Solomon Fabricant (1942); *American Agriculture, 1899–1939: A Study of Output, Employment and Productivity*, by Harold Barger and Hans H. Landsberg (1942); *The Mining Industries, 1899–1939: A Study of Output, Employment and Productivity*, by Harold Barger and Sam H. Schurr (1944). Studies in preparation cover other industries.

The exceptionally rapid growth of the two utilities does not mean that they behaved unlike the typical industry, that they were 'sports'. On the contrary, it is what one would expect of youthful or rejuvenated members of their species. Electricity, like automobiles, was in its infancy at the opening of the century; while gas (the manufacturing branch of which was covered in the Census as early as 1849), like petroleum refining, received a new lease on life at that time with the tapping of new markets, as well as with the addition of natural gas as a source of supply.[2]

The electric and gas utilities rose rapidly because the services they offered were superior in one way or another to competing services. Nearly everyone who became acquainted with the convenience, safety, and brightness of the electric lamp dropped other sources of light as quickly as he could. Most of us would not return to other means of illumination even if their prices were reduced to zero. The versatility of the electric motor, to name only one of its qualities, resulted in rapid displacement of steam engines, gasoline motors, water wheels, and animal power. Dr. Gould shows how the horsepower of electric motors used in manufacturing rose from 5 percent of the total horsepower of factory 'prime movers' in 1899 to 90 percent in 1939. In addition, uses were found for electricity, and gas as well, that could not be satisfied conveniently or at all by other means. Mechanical refrigerators would be far less popular today if they were operated by steam engines or coal furnaces. Further, the utilities offered their services more cheaply than these could be produced elsewhere, except, perhaps, in the establishments of very large consumers. The production of electricity in central stations thus grew more rapidly than it did outside that industry. For example, electric motors driven in factories by purchased energy grew from 38 percent of all electric motors in factories in 1899 to 65 percent in 1939.

The relative growth of the electric and gas utilities reflects, then, a shift to them of production formerly carried on in other industries or in the household; and an increase in the consumption of their services either at the expense of other, now less suitable services, or

[2] It is interesting to recall, in this connection, the fear expressed in English investment circles in the late 1880's of an imminent decline in the gas industry as a result of the quickening development of electricity (see Robert Giffen, *The Growth of Capital*, London, 1889, p. 23). But Giffen calmly refused to write off English gas investments in his estimate of Britain's wealth.

in the satisfaction of new demands. These factors remind us of those operating in many other rapidly growing industries, as we can see by a simple listing of some of these industries. During the period since 1899 there were automobiles, petroleum refining, canned food, and hosiery, cited above, and service trades such as commercial laundries. The railroads and the steel industry were outstanding examples during the 19th century.

Little can be said here about costs in electric stations and gas plants relative to costs elsewhere. But, drawing on Dr. Gould's study, we can give an account of the vast changes in materials, methods, and machines within central power stations and gas plants. In this way we can discover how reductions in their costs came about since the turn of the century. This is worth while because increased economy of resources utilized in producing and distributing electricity and gas helped so much to swell the output of these industries.

The chief material consumed by both electric and gas establishments is fuel. Reductions in fuel consumption per unit of product were effected in two ways. In the electric light and power industry, Dr. Gould points out, there was something of a shift from fuel-burning to hydroelectric stations, with a corresponding cut in fuel requirements per unit of electricity turned out. The percentage of current generated by hydroelectric equipment rose from 30 in 1902 (the Census year closest to the opening of the 20th century) to about 40 in 1907 and succeeding Census years. Within fuel-burning stations, further, the number of pounds of coal (or coal equivalent of other fuels) consumed per kilowatt-hour generated, declined from a little over 7 in 1902 to about 1.4 in 1937. Per kilowatt-hour generated by all plants, hydro as well as those burning fuel, the decline was from 5 pounds to one.

In gas manufacture there was a similar, though less intense, trend. In 1904, 28 percent of the heat value of fuel input, measured in British thermal units, was recovered in manufactured gas. By 1939 the percentage had risen to about 40. At the same time there was a net increase in the relative importance of natural as compared with manufactured gas; that is, a shift away from coal and toward natural gas. (We have noticed the outstanding rise in the extraction of oil and gas and in the distillation of petroleum products that paralleled this development.) As natural gas is cheaper than solid

fuel, at the place at which acquired by the utilities, a properly weighted index of material input for the gas utilities would have declined relatively to output even had there been no coal savings in gas manufacturing.

Economies in the use of materials have characterized other American industries also. In the National Bureau study of manufacturing, the cases of beet sugar refining, shoe manufacturing, steel mills, and coke ovens are cited, among others. Transportation is another example. While not of the same order of magnitude since 1899 as in the utilities studied by Dr. Gould, savings in these industries have been substantial, not only of fuel but also of other materials. The advances in technical knowledge that underlay the savings in electric and gas utilities were spread throughout the economy; modified by differences in basic techniques, they contributed to increased efficiency in almost every industry.

Labor too was economized in substantial degree by the utilities. In electric light and power plants the number of persons employed per unit of product was reduced 80 percent between 1902 and 1939; manhours per unit, almost 85 percent. In the gas utilities, workers per unit were cut about 55 percent from 1899 to 1937; and manhours per unit some 65 percent. The increase in the proportion of hydroelectric systems and the rise in natural gas, both of which require few factory operatives, have influenced these changes, of course. But the major factor has been greater efficiency in the use of labor within each branch of the utilities.

As with the increase in output, the two utilities were exceptional in the degree to which unit labor requirements were reduced. It is true that the cuts were matched or exceeded in some other industries: in 16 manufacturing industries, for example, workers per unit of product decreased from 1899 to 1937 more than the 55 percent in gas, and in 3 (automobiles, blast furnaces, and glass manufactures) the decrease approximately equaled or even exceeded the 80 percent in central electric stations. But it is clear, too, that these reductions in unit labor requirements were well above the average. In 35 manufacturing industries (we have records for 51), labor saving per unit of product proceeded at a slower pace than in the electric or gas utilities. The many changes felt throughout the economy during the first four decades of the century, among them improvements in capital equipment and new ideas on plant layout and

organization, made a deeper than ordinary impress on the two industries covered in Dr. Gould's report. However, as was true of output, the behavior of employment per unit of product in the electric and gas utilities appears exceptional only if we confine our attention to the 20th century. If we were to widen our field of vision to cover a longer period, and were to focus on industries showing rapid growth, whenever it occurred, it is very likely that we would find those industries characterized also by a rapid decline in unit labor requirements. Cotton manufacture, railroads, and steel production are the first to come to mind.

Rapid as were the reductions in unit labor requirements in the electric and gas utilities, the sale of their products rose so substantially as to induce considerable increases in employment. The number on payrolls of the electric light and power industry increased ninefold from 1902 to 1939; and in the gas industry, between 1899 and 1937, threefold. With the total labor force of the United States approximately doubling during the first four decades of the century, this meant that the utilities provided new sources of employment, despite greatly increased economy of labor per unit of product. In this respect, too, they illustrate tendencies frequently found to prevail among other industries. In manufacturing, our studies reveal, employment often rose rapidly in industries in which labor per unit fell at above-average rates; for it was also in these industries that output increased at exceptional rates.

There is at least one attribute shared by the electric and gas industries that sets them definitely apart from most other members of their species. In both, capital investment is far higher in relation to labor used than is generally the case among industries. One indicator is the ratio of their total contribution to national income in the form of wages, salaries, dividends, rents, and undistributed profits to their contribution in the form of wage and salary payments alone. According to figures prepared by Simon Kuznets,[3] in the electric power industry and in manufactured gas these ratios, 2.8 and 1.8 respectively, exceeded those for all other industrial divisions except pipe lines, real estate, and agriculture. (The high ratio for agriculture reflects the fact that much of its labor income appears in the form of profits accruing to entrepreneurs, rather than

[3] *National Income and Its Composition, 1919–1938* (National Bureau of Economic Research, 1940).

as wages or salaries.) Natural gas, related as it is to pipe lines, must also have a high ratio, though no separate figures are available. Expressed more directly, for each person employed in electric light and power stations in 1937 about $45,000 was invested in fixed capital assets; and for gas plants, something over $25,000. In manufacturing as a whole, for example, the corresponding figure was only $2,500.

With capital so important in these two public utilities, it is desirable to compare trends in their use of capital with trends in their output. Deflating reported book values as well as he can, Dr. Gould finds that in electric plants fixed assets multiplied more than 10 times between 1902 and 1937. The corresponding increase in employment was ninefold, and in output fortyfold. For manufactured gas (data for natural gas are lacking), the changes between 1904 and 1937 are less extreme: deflated capital assets rose 27 percent, employment 50 percent, and output 210 percent. In neither industry, it seems, did deflated capital assets grow as rapidly as output. In manufacturing as a whole the differences are smaller, though otherwise roughly similar: deflated assets rose somewhat over 120 percent from 1904 to 1937 while output increased 200 percent, and employment 70.

Dr. Gould emphasizes, rightly, the crudity of the figures on capital values. He therefore devotes some of his attention also to other aspects of capital investment. For electric stations he uses kilowatt capacity, and finds that kilowatt-hours generated, per kilowatt of capacity, increased 60 percent between 1902 and 1939. For manufactured gas, he uses number of miles of gas mains, and finds that cubic feet of gas sales, per mile of mains, increased 15 or 20 percent from 1909 to 1939.

As the electric power industry was very young in 1902 (fixed assets amounted to a half-billion dollars), the $12 or $13 billion of fixed assets it held in 1937 represents almost entirely net investment during the intervening period. In manufactured gas net investment was almost $1.5 billion between 1904 and 1937 — fixed assets rose from $.6 billion in the earlier year to $2 billion in the later. If we exclude natural gas and ignore problems of valuation and revaluation, as we must, that means some $14 or $15 billion of investment in 35 years. The magnitude may be best appreciated when compared with other figures on investment. For manufacturing,

including such giants as food, steel, petroleum products, machinery, and automobiles, the net investment between 1904 and 1937 was of the order of $18 billion. Total net investment in all industries (including residential construction) equaled about $150 billion. It is true, of course, that assets in electric and gas plants are long-lived and have been growing more steadily than in most other industries. If *gross* investment were considered, the relative importance of these industries would therefore be reduced. Yet it is fair to say that the two utilities covered here constituted an important field for investment during the three or four decades preceding World War II; and because of their high ratio of capital to labor, a field far more important for investment than for employment.

The electric and gas utilities effected savings in the use of major items in each of the three main classes of resources. There were reductions, per unit of output, in fuel consumed, in labor employed, and in fixed capital invested. Dr. Gould wisely refrains from combining these measures into a single index of total resource input per unit of product, partly because he was unable to measure each type of input in all its aspects and partly because of the theoretical difficulties involved. He contents himself with leaving with the reader the clear implication that since all three of the 'partial' indexes of input-output ratios declined, the input of resources as a whole, per unit of product, also declined.

Perhaps the best available single measure of total resources used per unit is the price at which each unit of product is sold. It too has limitations. It provides no absolute index: one can learn only that the input-output ratio has risen or fallen more or less than corresponding ratios for other industries; it is complicated by questions concerning the markets in which the prices are set; and it is not easy to obtain except for short periods. It is, however, interesting to note what it shows.

City consumers paid 30 percent less for electrictity in 1937 than in 1914, according to the National Industrial Conference Board index (which is unaffected by changes in type of sales or areas served). They paid 22 percent more for gas, both natural and manufactured.[4] In contrast, their general cost of living rose 43 per-

[4] The very large increase in average revenue per thousand cubic feet of natural and manufactured gas, shown in Dr. Gould's computations, presumably reflects the gradual inclusion of localities distant from gas wells in the market served by natural gas com-

cent. Retail prices of electricity and gas fell also in relation to the average wholesale price of the various kinds of goods covered by the Bureau of Labor Statistics index.

We should recall here that labor per unit in these industries was reduced more than in other industries. Greater than average cuts (or lower than average rises) in prices were therefore associated with greater than average reductions in labor per unit and also with above-average increases in output, employment, and capital. These relations, too, characterize manufacturing and other industries. In the National Bureau study of manufacturing it was found that industries leading others in respect of increase in output led them also in respect of rise in employment and in capital assets, and of decline in labor per unit, wage cost per unit, and selling price. The automobile industry is the leading example at one end of the scale. At the other end were lumber mills, lagging relatively to other industries in these various respects.

By all indications, then, the quantity of resources required to turn out a unit of product has been reduced in the electric and gas utilities. Fuel, capital, and labor used per unit in the period just preceding the outbreak of World War II were below corresponding quantities at the opening of the century; prices, relative to other prices, were lower. In short, there was a real increase in efficiency. Credit for this contribution to economic welfare must be given in part to the utilities themselves. But a share also belongs to other industries, working together with the utilities, as is obvious in the case of improvements in capital equipment, a major factor in the greater efficiency of the use of resources. These improvements in machines reflect increased knowledge in the industries producing the equipment and in the industries making the materials going into the equipment, as well as in the utilities ordering and using the equipment. If economies of large scale production made for increases in efficiency in the utilities, as is likely, the entire economy is also to be counted as a contributor.

The reverse is true as well. The development of the utilities enhanced the productivity of the industries they served. As we have seen, they took over the functions of providing light, heat, and

panies. Widening of the area served would, because of the greater distance traversed, cause average revenue per unit to rise: however, natural gas prices are still lower than those of manufactured gas, despite a sharp rise in the one and little change in the other.

power. They improved the effectiveness of these sources of energy. They provided the means without which the use of such versatile instruments and machines as automatic controls and electric motors is not practicable. In short, the development of the electric and gas utilities contributed to the rise in the American standard of living in various ways — ways, too, in which other industries contributed.

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