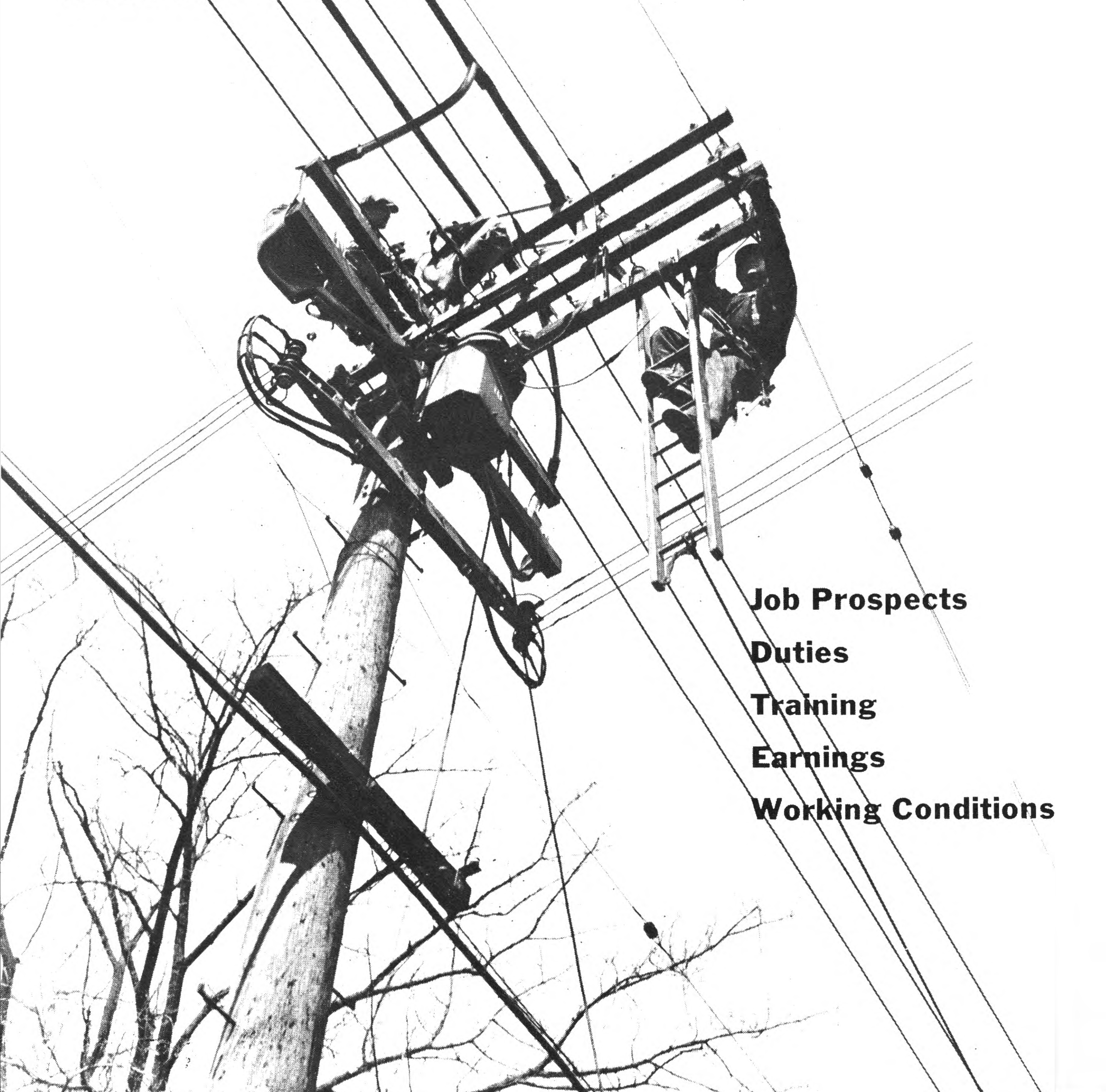
EMPLOYMENT OUTLOOK IN

ELECTRIC LIGHT AND POWER OCCUPATIONS



Job Prospects

Duties

Training

Earnings

Working Conditions

UNITED STATES DEPARTMENT OF LABOR • BUREAU OF LABOR STATISTICS

OCCUPATIONAL OUTLOOK SERIES • BULLETIN No. 944

Linemen at work on top of pole. These workers make up the largest occupation in electric utilities.

Employment Outlook in

Electric Light and Power Occupations

Bulletin No. 944

UNITED STATES DEPARTMENT OF LABOR
MAURICE J. TOBIN, Secretary

BUREAU OF LABOR STATISTICS
EWAN CLAGUE, Commissioner

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Letter of Transmittal

UNITED STATES DEPARTMENT OF LABOR,
BUREAU OF LABOR STATISTICS,
Washington, D. C., September 23, 1948.

The SECRETARY OF LABOR:

I have the honor to transmit herewith a report on the employment outlook in electric light and power occupations. This is one of a series of occupational studies prepared in the Bureau's Occupational Outlook Service for use in vocational counseling of veterans, young people in schools, and others considering the choice of an occupation. The report was prepared by Richard H. Lewis. Vincent Arkell assisted in the research, and Bella D. Uranson assisted in the collection of the data.

The Bureau wishes to express its appreciation to the officials of trade associations, trade-unions, electric light and power companies, and Government agencies who have provided valuable information or read all or part of the manuscript.

EWAN CLAGUE, *Commissioner.*

Hon. MAURICE J. TOBIN,
Secretary of Labor.

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Employment Outlook in Electric Light and Power Occupations

Introduction

Just as Aladdin could summon the genie by rubbing his magic lamp, so today people in over 40 million homes, stores, and factories can have the power of electricity at their fingertips merely by snapping a switch. This modern magic has been brought about through the growth of electric utility systems which generate electric current from steam power or water power to be used for lighting, heating, and cooking and to operate the machines and electrical instruments which are typical of modern industry. To bring power to the consumer an elaborate set of facilities—power plants, substations, overhead wires or underground cables, and meters—is required. Operating and maintaining this equipment and carrying on the technical, commercial, and administrative services are 330,000 employees of privately and publicly owned power systems.

This industry is a major source of employment opportunities. Utility systems now blanket the Nation, and electric power jobs are found in all sections of the country. Many different types of technical and skilled workers are needed to insure the dependable electrical service that utility systems render, including such workers as electrical engineers, power plant operators, linemen and troublemen, meter readers and repairmen, and workers in every major office occupation. In many communities the local utility is one of the best sources of interesting and steady jobs.

What Are Electric Utility Systems?

An electric utility system is an organization which uses a complex set of equipment —power plant, substations, and wires—to make electric current and carry it directly to places where it is used. It is often convenient to think of the operations of electric utilities and the employment opportunities in them mainly in terms of the privately owned companies which make up the electric light and power industry. They produce most of the power consumed and employ the great bulk of the workers in the field. Much of the discussion of utility employment trends will relate to the private systems. However, as we shall see later, there are Federal and local government owned utility systems operating in some localities, and they are also an important source of electrical jobs.

Function of Utility Systems

Electric light and power companies are in business to sell a service rather than to produce and sell a tangible commodity. The service they render is bringing electric current right to the user from a central source.

Since each customer has access to the supply of current by merely pushing a switch or a button, the companies must always stand ready to send over the wires the total amount of power needed by the consumers at any single moment. Electric power cannot efficiently be stored in large quantities but is produced and used almost simultaneously, passing instantly over the wires from the generators to the electrical equipment of the customers.

Thus a company must vary its output hour by hour as the needs of the users change. To do this it must have production capacity ample to handle the maximum demands for electric power that can be expected from its customers at any one time, even though at other times, such as during the hours between midnight and 6 a. m., much of the equipment may stand idle. Because of the nature of the uses of electricity and the fact that production and use are almost simultaneous, uninterrupted service is very important. To ensure a continuous and dependable supply of current to the users, a utility system must not only keep a staff of workers on duty at all times to operate its equipment but must be vigilant in maintaining the equipment and speedy in making emergency repairs.

Electric utility systems, like telephone, telegraph, and local transit services are considered public utilities. This is not only because of the great importance of their service to the public, but because it has been considered best for efficient operation to allow only one company to operate within a particular area. Otherwise there might be wasteful and costly duplication of services, and an impossible confusion of electric lines. Thus the local governing body, which may be a city, town, or county, grants the right to operate to one company. An individual home owner or a businessman cannot choose his power company as he does his grocer or bank, but must buy current from the utility operating in his locality. Employment opportunities in electrical work are also affected, since those who want to work for a light and power company will usually find only one possible employer in their community.

As a condition of granting this right to power companies to be the sole operators in a specified area, and to place their equipment in publicly owned property such as streets, governmental bodies maintain certain controls over them. This is most important in the setting of rates, which must be approved by the governing agency, which is, in most States, a Public Utilities Commission. The Federal Power Commission also has an important part in regulating the activities of utility systems.

Importance of Plant and Equipment

The nature of the service that electric utilities render, involving the production and distribution of large quantities of power and carrying it directly to a multitude of individual users, requires an extensive and complicated system of physical facilities. Generating stations, substations, transformers, and transmission and distribution lines are the major types of equipment included in the network which takes power from the source to the user. A steady drive toward greater efficiency in operations has stimulated the companies to an increasing utilization of mechanical equipment wherever possible and has resulted in larger and more complex power producing units.

As of the end of 1947, the facilities of privately owned electric utilities were valued at over 13 billion dollars. This represented a larger investment than in any other industry except railroads.

The fact that electric utilities depend so heavily on equipment affects the number and kinds of jobs in several significant ways. In the first place, fewer employees are needed than in other industries in comparison with the volume of sales. The number of men required to actually operate the equipment is only a small part of the total workers in the industry, much less than the percentage of production workers required in most other industries. The workers in the operating departments mainly control, regulate, and check the operation of the equipment. Since the light and power industry does not make a tangible product such as automobiles or radios, fabricating and assembly work is not required.

Because of the great importance of the equipment and the need for keeping it in good running order, many of the workers in utility systems are in maintenance jobs or in installation work. Also, since the operating staff is relatively small, commercial and administrative workers comprise a large part of the total employment—much more so than in most other fields.

As a result of the high degree of utilization of equipment, the number of operating workers needed at a particular time is more closely related to the production capacity of a utility system than to its actual level of output. There can be sharp changes in the output of electricity without corresponding changes in the number of workers needed. Furthermore, since the process is carried on by the equipment, with manpower needed mainly to check and control, the introduction of new and more efficient equipment has made possible great increases in output per worker employed. This has limited the employment needs of the electric light and power industry despite the tremendous increases over the past several decades in the quantities of electric current produced.

How Electricity is Made and Distributed

The easiest way to visualize the process of making current in a central power plant and furnishing it to a diversity of customers is to follow it step by step through the three basic operations—generation, transmission, and distribution. Chart 1 gives a simplified picture of how the electric current is generated and then flows from the generating station and through the transmission and distribution systems to the individual users.

The electric utility industry is unique because of certain characteristics of electricity which make it differ from other commodities. Electricity is an intangible force. Having no dimensions it cannot be packaged, wrapped up, and shipped to the customers. It cannot be efficiently stored in large quantities but must be used almost the same moment it is produced. Each customer can begin to use current or increase his consumption at any time by merely pushing a button. For this reason a power company must have a permanent installation of equipment which provides for moving electricity in the required amounts to users as their demands indicate. It is this instantaneous delivery of electricity to the user as he needs it that is the distinctive feature of the operation of electric-power companies.

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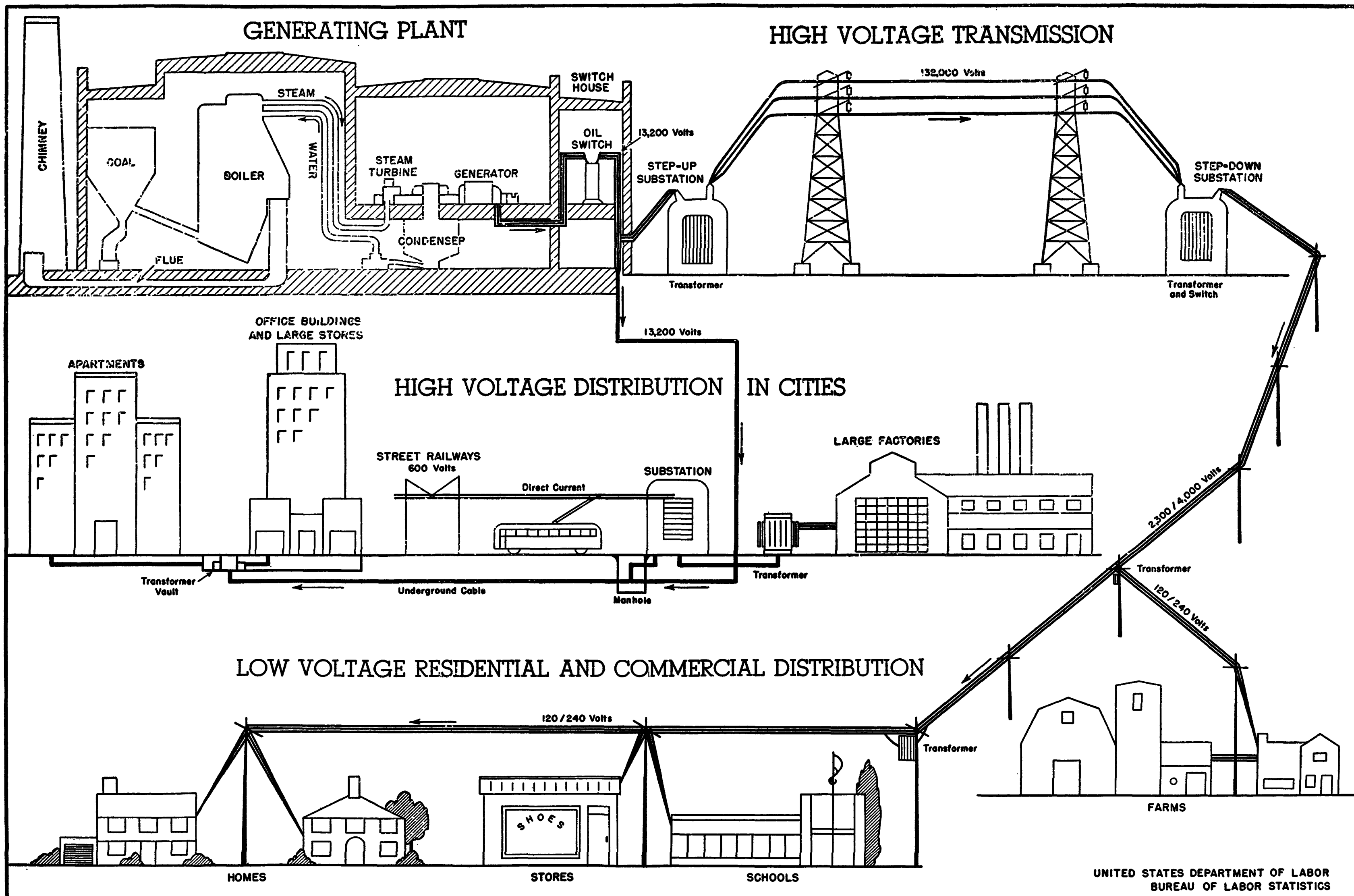
Power Plant Operations

Electricity is produced in the power plant through the operation of electric generators. The principle upon which the generator operates is that when an electrical conductor, such as copper wire, is moved across a magnetic field an electric current is set up in the conductor. The purpose of the generator is to change mechanical energy to electric energy by making use of this principle. A generator consists mainly of two parts—a cylindrical steel shell called the stator, and a steel drum mounted upon a shaft which revolves inside the shell and is called the rotor. The stator and the rotor each has an elaborate set of electrical coils and wiring mounted upon it. An electric current is sent through the coils on the rotor to create a magnetic field. The rotor is then revolved at great speed. When the lines of magnetic force from the magnetized rotor cut across the coils on the stator (or armature) an electric current is generated.

The amount of current produced depends upon the size of the generator (the number of windings and coils on the stator and the rotor) and the speed at which the rotor revolves. This speed ranges as high as 3,600 revolutions per minute in some modern generators. The current produced is usually alternating, that is, it reverses its flow at regular intervals, many times per second.

The basic operation in the power plant is providing the mechanical energy to drive the shaft of the generator's rotor. Although electricity is commonly thought of as a type of power, in fact it is but a means of transmitting the energy developed from basic sources of power such as coal or waterfalls. Thus the electric current serves the same purpose as the transmission system of an automobile in carrying the force developed by the engine and applying it to the rear axle and wheels. Most electric current is generated by power obtained from one of these main sources: Steam produced by burning various fuels; the flow or fall of water; or the operation of internal com-

Chart 1.—How electricity is made and brought to the users



bustion engines. Other sources of power are available, such as windmills, but their use is insignificant.

Steam is the most important source of power for electric generation in this country. Formerly steam engines were used to drive the electric generators, but for many years the force of the steam has been changed into electric energy by sending it through steam turbines, which in turn drive the generators. In 1947 about 68 percent of the electric energy was produced in steam power plants.

The second most important source of power is that obtained from flowing or falling water. The water turns the shaft of a turbine which drives an electric generator. About 31 percent of the electricity generated in 1947 was produced in hydroelectric power plants.

Internal combustion engines are frequently used as a source of power for electric generating plants. Oil-fueled Diesel engines are the main type employed. Internal combustion engines are typically found in small power plants, since steam plants can more efficiently produce large quantities of current. Thus, even though there are a large number of Diesel generating stations, they produced only about 1 percent of the electric energy in 1947.

Steam Power Plants

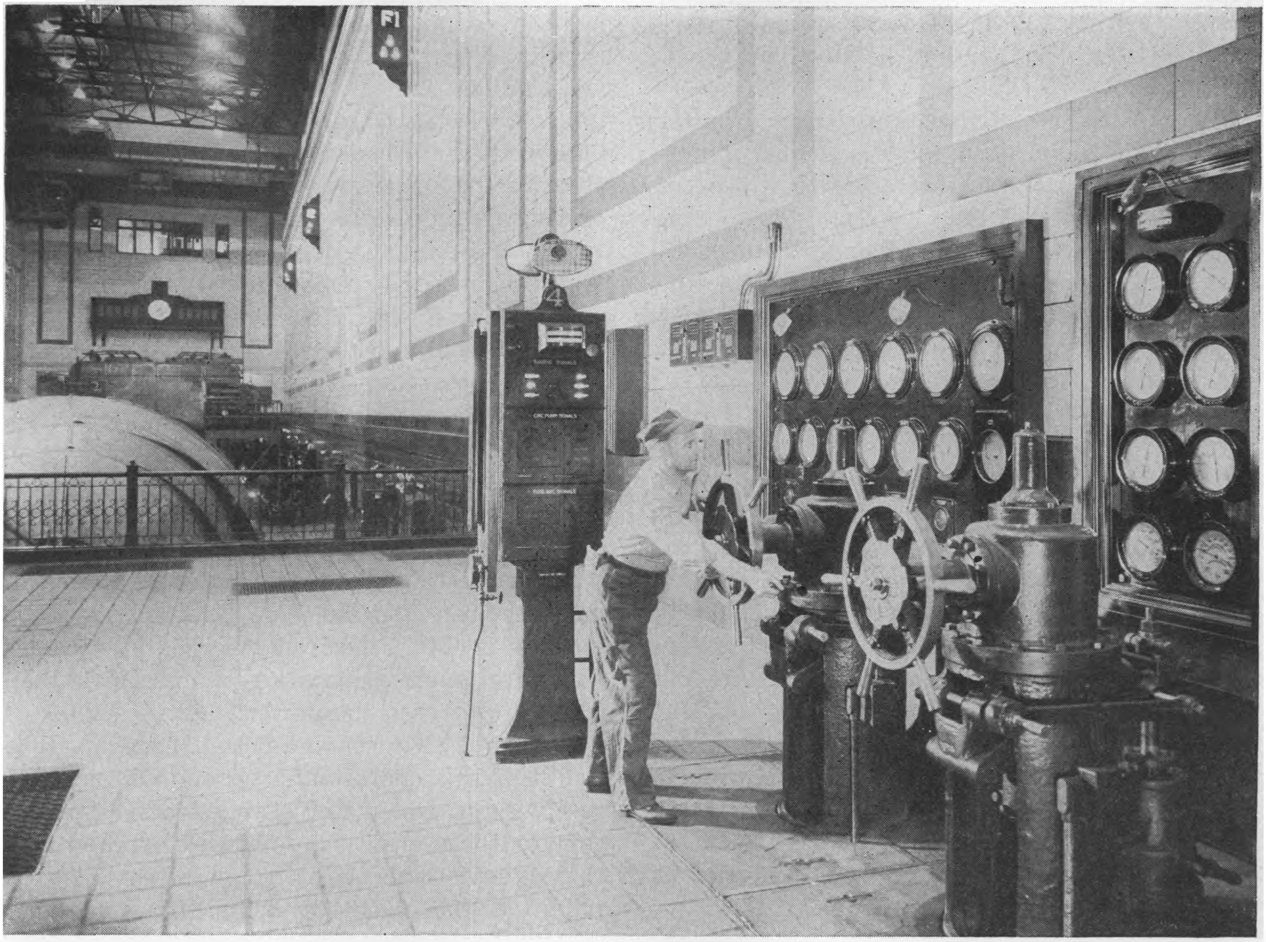
In steam power plants, high temperature steam is produced in large boilers. The fuel burned in the furnaces is usually coal, but in some sections of the country oil or natural gas is the main source of heat. The steam produced in the boiler is brought through pipes to the turbine room, where it is directed with great pressure and at high temperatures against the blades of an enclosed turbine.

A steam turbine is a device which takes the force of the steam and uses it to drive a revolving shaft. This shaft is coupled directly to the shaft of the generator's rotor, and the turbine and generator are almost always housed in a single unit. The turbine, which is based upon the principle of the water wheel, has a series of blades, buckets or vanes attached to its shaft. The steam is ejected at great speed from a set of nozzles. As it strikes the blades or buckets it causes the shaft to revolve rapidly. The steam passes from one set of blades to the next in the enclosed turbine so that its force is utilized to the maximum possible extent. In addition to boilers and the turbogenerator units—the basic equipment of the steam power plant—there are several types of equipment essential to efficient operation of a large generating station. Among the most important types of auxiliary equipment are condensers, which change the steam into water after it has passed through the turbine, water pumps, coal and ash handling equipment, fans and blowers, and air compressors.

After the electricity is generated it passes through a complicated process known as switching before it flows out on the power lines leading away from the generating station. The current from all the various generators in the power station is first combined in a set of conductors called the bus system. A bus is made up of a group of heavy copper bars or cables supported upon insulators. The current is then directed out onto the power lines by means of a system of switches and circuit breakers. The object of this operation is to see that each line receives the amount of power required at the time by the users it supplies. In a small system these lines may be directly connected with distribution lines of the company, but in a large system the power usually goes first onto the high voltage transmission lines leading to substations. If the current is to go out over a transmission line its voltage (force) must be raised above the generating voltage by passing it through a step-up transformer usually located adjacent to the power plant.

The switching operations are controlled by operators attending the switchboards in the control room of the power plant. Instruments in the control room, besides providing for the switching of the current, also show the total current leaving the station and the power load on each line. The operators in the control room also direct the starting and stopping of the generators to meet the changing power requirements on the station.

Steam power plants are usually located near the center of the area they supply so as to reduce the distances that the current must be transmitted. Their location is also affected by the need for large quantities of cool water for use in condensing the steam, so that where



Turbine operators must keep constant check on steam pressures and temperatures and the speed of the turbines. A turbogenerator unit is shown in the background of this view of the turbine room.

possible they are placed on the banks of a river or lake. As mentioned previously their efficiency is greater in large sizes; new installations usually have large units of equipment, and the total capacity of the plant is as large as the power needs of its service area warrant.

Hydroelectric Power Plants

The operation of a hydroelectric power plant differs considerably from steam generation. The source of power is usually falling water, the water being directed through a water turbine to drive a generator. The fall of water may be from either a natural source, such as a waterfall, or an artificial one, as at a dam. The height which the water drops is called the "head." It is this height, together with the volume of the water flowing over a falls or stored behind a dam, which determines the amount of water power available at a particular installation. If the power plant is situated at a waterfall, some of the water in the stream is diverted from the falls and rushes down through pipes to the turbines at the foot of the falls. To operate a power plant at a dam, water is stored and then sent through large pipes leading from the top of the dam to the turbines in the power plant at the base of the dam.

There are several different types of water turbines, but each consists of a wheel or "runner" mounted upon a shaft. The runner has blades, vanes, or buckets to receive the force of the water, and the force of the water against them turns the shaft. The water after passing through the runner is discharged into the stream. The shaft of the turbine is directly connected with the generator. As it revolves it drives the rotor of the generator, producing the electric current. The current is controlled and switched onto the power lines leading away from the hydroelectric plant much the same as in a steam power station.

It is obvious that hydroelectric power plants are placed only at sites where water power is or can be made available. However, their location must be planned to the needs for electricity in particular areas because of the limited distances that electricity can be efficiently transmitted. Considerable progress has been made in increasing the distances that electric lines can bring power from far-off hydroelectric plants to the users in cities, but the farthest that current is now regularly sent is the 270 miles from Hoover Dam to Los Angeles. Thus many locations suitable for hydroelectric projects have not been developed because the areas surrounding them are sparsely settled and not industrialized and would have relatively low electric power consumption. On the other hand the densely populated eastern sections of the country are located at too great distances from the western areas which contain most of the potential sites of large scale hydroelectric power.

Most utility systems that have hydroelectric power plants must maintain steam power plant capacity in reserve to handle the power demands during seasons when the volume of water in the stream or storage dam is low. Except for sites like Niagara Falls, which gets a nearly steady flow of water from the Great Lakes, and Hoover Dam, whose storage capacity is very great, the output of hydroelectric plants is affected by season-to-season and year-to-year changes in the amount of rainfall and snowfall and the resultant water flow.

The generators used in hydroelectric power plants are larger than steam-driven generators of the same capacity. Water turbines revolve at much lower rates of speed than do steam turbines, and this reduces the output that can be obtained from a generator of a particular size.

Internal Combustion Engine Power Plants

In the third type of power plant, internal combustion engines drive the generators. Gasoline engines are sometimes used, but in most cases oil-fueled Diesel engines are the source of power. The production process is relatively simple, each Diesel engine directly powering a generator. Diesel generating plants are more flexible than steam plants and produce current in small quantities more efficiently than steam equipment. On the other hand steam plants have economies in large scale production not possessed by Diesel plants. Since Diesel engines are used mainly in the smaller generating plants, the operations involved in switching the current onto the power lines are relatively simple.

The Transmission System

After the electricity leaves the power plant it passes onto the transmission lines which link the generating plant and the distribution network serving the individual customers. The purpose of the transmission system is to efficiently take the electric current over relatively long distances, or in large quantities to places where it can be split up and fed into the distribution lines. Thus transmission lines may carry the current from a distant hydroelectric power plant to the city where it is to be used. Or they may carry current from a power station in a city to a substation in the outlying areas served by the power company. Within large cities, transmission lines carry power from a central generating station to the distribution substations in the various neighborhoods. Transmission lines also serve to tie together the separate generating stations of a system so that power can be exchanged between them and the demand for electric power be distributed among them, or to connect the power facilities of separate systems. The transmission system can be pictured as similar to the main line of a railroad which carries a large volume of freight in long freight trains from one city to another—at the end of the line the shipments being separated and sent over many branch lines to their final destinations.

Power can be sent over wires more efficiently if high voltages are used. Voltage is the measure of electrical force or pressure. Some electric energy is always lost (in heating the wires or through escaping into the air) when it passes through wires or other electrical conductors. These power losses are reduced however when current is sent at high voltage. It was to a considerable extent the development of equipment and methods for raising the voltage of current and then reducing it for use by consumers that made possible the establishment of the complex large scale electric utility systems that we have today. The transformer is the most important single device used in the transmission and distribution of electricity. A transformer consists of an iron core surrounded by two wire coils which are wound in such a way that current passed through them can be increased or decreased in voltage.

If electric power is to be sent over transmission lines its voltage is raised by sending it through a transformer in a step-up substation, which may be located in the power plant or adjacent to it. Often the transformers are placed in the open in what is called a transformer yard or switch yard. Transmission lines in outlying areas are usually carried on widely spaced tall steel towers, stretching across the countryside. In cities and other built up areas the transmission lines are usually carried in lead-sheathed underground cables. The transmission system ends at a step-down substation, where transformers reduce the voltage to a point where the power can be passed on to the distribution system.

The Distribution Network

The step-down substation acts as a sort of transfer station between the transmission lines and the network of distribution lines. From it run a large number of "primary" lines into the various sections of the city or area served by it. Thus not only is the current reduced in voltage but the total quantity of power coming in on the transmission lines is split up to be sent out over the distribution lines, the amount going out over each line at any one instant depending upon the requirements of the users served by it.

A distribution system can be pictured as beginning with the substation and fanning out into a spider web of lines from which in turn other wires are run until the final user is reached. A large industrial user may be served by a line running directly from the substation. But individual homes get their current from "secondary" and "feeder" lines which branch off from the main lines leading away from the substation. These may run through several residential or business blocks, individual drop-off wires bringing the power into each building.

The main wires running from the substation carry current which, even though reduced from the transmission voltage, is still far too high for use by individual customers in their lights or appliances. To make the final step-down in voltage "line" transformers are mounted along the wires at points where "feeder" lines branch off. Distribution lines are usually strung from cross arms mounted on wooden poles. In the heavily built up sections of cities, however, the distribution lines are in underground cables running in tunnels beneath the streets and are reached through manholes placed at frequent intervals.

As the electric power enters the wiring system of the customer's building it is measured by passing it through a meter installed by the utility. After the current is measured so that the customer can be billed for his consumption the physical operations of the utility in bringing power to its customers are completed.

Publicly Owned Systems

Most of the electric power used in the United States is produced by privately owned utility companies. In recent years, however, various public agencies have become increasingly important in its generation and distribution. At the end of 1947, 10,335,525 kilowatts of capacity, representing almost 20 percent of the Nation's total generating capacity, was publicly owned. Almost half of the public capacity was operated by agencies of the Federal Government. Most of the remainder was in municipally owned power systems. Public power districts, covering portions of some States, and rural cooperatives sponsored by the Rural Electrification Administration had over 1,200,000 kilowatts of power capacity between them; most of this was owned by the power districts.

The federally owned systems are operated principally by the Bureau of Reclamation and the Bonneville Power Administration of the Department of the Interior, and the Tennessee Valley Authority. The Corps of Engineers of the War Department also operates a few plants. Most of the federally owned generating capacity is in hydroelectric plants which obtain water power from large storage dams. These dams were usually built as part of reclamation, navigation, or flood control projects and serve these purposes as well. Hoover Dam on the Colorado River and the dams of the Tennessee Valley Authority are examples of this dual function. Except for the Tennessee Valley Authority, which provides power to most of Tennessee and parts of Alabama, Kentucky, North Carolina, and Mississippi, most of the Federal power projects are located in the western sections of the country.

The federally operated facilities are limited mainly to generating plants and to high voltage transmission lines which take the current from the powerhouse to connecting points with the distribution lines of other systems. Most of the power generated is sold either to large industrial users or to privately owned or publicly owned utilities, which then distribute it to their individual customers. For example, a large part of the electric power from Hoover Dam goes to the Los Angeles municipal power system, which then resells it to homes and factories in Los Angeles. Since the biggest share of the employment in electric utility operations is required for distribution of the power to individual customers and in billing them for it, employment in Federal power projects is much less than would appear when considering their large generating capacity.

A few large cities operate their own electric power systems, but most of the municipal systems are in the smaller cities and towns. Many of these have found it more efficient to buy their power from larger utilities, either private or Federal, and merely distribute it to individual users in the community.

The rural electrical cooperatives are not government owned or operated but are financed by loans from the Rural Electrification Administration, a Federal agency, which also provides technical assistance and administrative guidance. Each cooperative is owned and controlled by its members, who are mainly farmers in the area served. The program of federally sponsored rural cooperatives was begun only a little over a decade ago but has grown rapidly until now over 2,250,000 customers are served. Most of these are on farms, but many are in the small towns in the rural areas. Most of the co-ops do not make their own electric power but buy it from other systems—both private and Federal. Their principal purpose is to extend power lines into the areas that are not reached by existing utility systems and thus give farmers the benefits of electric service. In the first part of 1948 the 925 active co-ops had almost 700,000 miles of power lines in operation. Although not a major source of employment, the co-ops have opened up electric utility jobs in areas where none existed before and should interest those who want to get in electrical jobs in rural regions. In the local cooperatives there are jobs for such workers as managers, accountants, engineers, linemen, and metermen.

Concentration in Large Systems

Although there are more than 4,000 electric utility systems in the United States, including the publicly owned and the cooperatives, most of the generating capacity and the employment is concentrated in a relatively few systems. In 1946 for example, 35 companies had 60 percent of the total generating capacity operated by class A and B privately owned utilities (which include all except the very small systems). Most of the federally operated capacity is in large projects, and there are several large municipal systems which account for a good share of the municipal capacity. Most of the rural cooperatives are relatively small.

The situation is similar with respect to employment. Although there were many systems with a small number of employees scattered throughout the country, companies with more than 250 workers had more than 93 percent of the private utility employment in July 1945.

A high proportion of the power produced comes from a relatively few large size generating plants. This is especially the case in steam generating plants, where, up to a certain point, the efficiency of generation increases with the size of the units of equipment. At the end of 1946, almost two-thirds of the total capacity in class A and B privately owned steam generating plants was in plants with over 100,000 kilowatts of installed capacity, even though there were only 94 stations of this size out of a total of 650. The average size of the privately operated hydroelectric plants was much smaller. Internal combustion engine plants are typically small, since their maximum efficiency is reached at relatively small sizes. Only 4 of the privately owned internal combustion engine generating plants had more than 5,000 kilowatts capacity in 1946. A good share of the federally owned generating capacity is in large hydroelectric installations such as at Grand Coulee and Hoover Dams. The capacity of the generating plant at Hoover Dam is over 1,000,000 kilowatts, and Grand Coulee Dam in the State of Washington will eventually have almost 2,000,000 kilowatts when its power plants are completed.

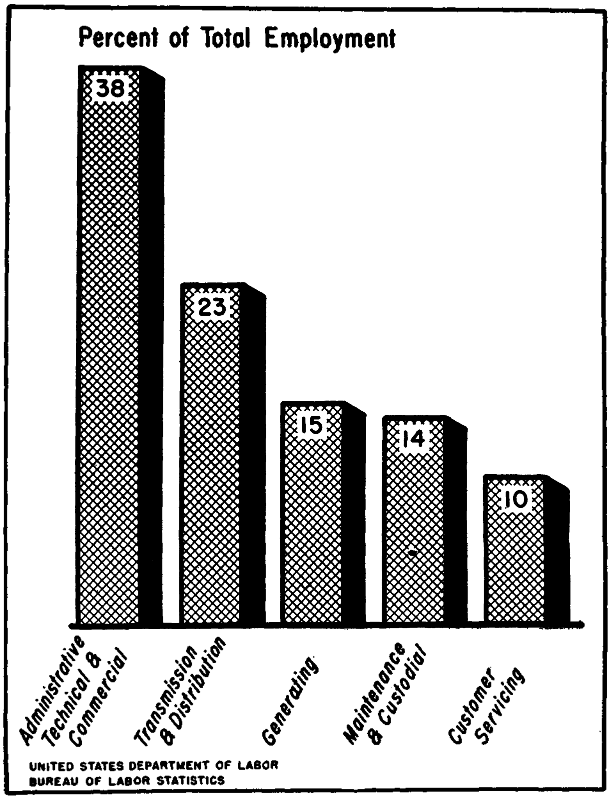
Electric Utility Jobs

Electric utility systems are one of the most important sources of employment. It is estimated that in June 1948 more than 330,000 workers were engaged in electric power operations. The bulk of these, 279,000, were employed by privately owned systems. Almost 36,000 worked for municipalities or local power districts covering portions of States, most of them in the municipal systems. Federal operations accounted for almost 6,000 electric utility employees and rural cooperatives had about 11,000. The totals for private systems include some workers on nonelectrical operations in companies that provide other services, such as gas or local transit, in addition to electric service.

Kinds of Jobs

A look at the different kinds of workers needed in the electric utility operations shows at once that there is a great diversity of jobs. Chart 2 shows the relative importance of the major job groups included in the labor force of the privately owned electric light and power industry. First there are the basic jobs in the generation of electricity, those of the power plant workers. These include boiler operators, turbine operators, and auxiliary equipment operators who watch over and check the equipment which produces the power, and the watch engineers who supervise them. Estimates of the number employed in the individual powerplant occupations and also of some of the more important jobs in other departments are given in the list below. Also in or connected with the generating station are the switchboard operators, whose job it is to control the movement of the current on to the power lines which carry it away from the generating station. These and the related workers needed for the actual generation of the electricity amount to

Chart 2.—Administrative, technical, and commercial activities employ almost 40 percent of the workers



only 15 percent of the private electric utility employees.

Occupations	*Estimated employment, April 1948*
Electrical engineers (including those in administrative positions)	16,000
Power plant occupations:	
Auxiliary equipment operators	5,000
Boiler operators	5,700
Switchboard operators	5,200
Turbine operators	4,000
Watch engineers	2,200
Transmission and distribution occupations:	
Cable splicers	1,400
Groundmen	12,000
Linemen and troublemen	23,000
Load dispatchers	1,500
Substation operators	8,000
Customer servicing occupations:	
District representatives	3,000
Metermen	5,500
Meter readers	6,600

A somewhat larger number of employees are engaged in the next stage of getting electric power to the users—the transmission lines and the distribution networks. The workers in the transmission and distribution department, which requires about 23 percent of the private utility employees, include substation operators who control the transformers and switching equipment, and linemen who install and repair overhead lines. Cable splicers set in place and maintain underground cables. Load dispatchers although relatively few in number are the key workers of the entire production and distribution operations, for they control the flow of electric current throughout the utility system. Other workers in this department are the groundmen who assist the line crews, the laborers who help construct underground cable systems, and the patrolmen who walk along the electric lines in isolated areas to look for conditions that could cause trouble on the lines and equipment.

Another group of workers who help to carry on the actual operation of electric utilities are those in customer servicing jobs. Among this group, which accounts for about 10 percent of utility employment, are the metermen who test and repair meters and the meter readers who record the consumption of electric current so that the customers can be billed for the service. In rural areas it is common to employ men called district representatives, who, in addition to reading meters periodically, act as a company's local agent to receive reports of service break-downs and handle less important matters that come up between the electric company and its customers in localities where the company does not have an office.

The operation of an electric utility system is largely a matter of keeping the equipment running efficiently, so it is natural that a large force of maintenance workers should be required. Maintenance and custodial employees, excluding those who work on the lines, cables, and meters, comprise about 14 percent of private electric utility employment. Among the more important workers in the maintenance shops are electricians, machinists, mechanics, boilermakers, painters, carpenters, and welders.

Because of the nature of its services and the way its production is carried on, the electric light and power industry employs a higher proportion of administrative, technical, and commercial employees than do most other industries. In the industry as a whole almost 40 percent of the workers were in such jobs. In many companies there were as many of these office employees as there were of the production and maintenance workers combined. For this reason, power companies are one of the most important sources of jobs for accounting, clerical, and other office employees in many localities. The relative importance of office employees in the industry is accounted for partly by work involved in billing and collecting from the multitude of individual customers; and also by the fact that large numbers of workers are not needed in the actual generation of electric power.

In addition to preparing bills and keeping records of customers' accounts, clerical workers are also used to maintain the general financial records of the company, to purchase new supplies and equipment, and to maintain extensive inventory records for them.

Electric utility systems employ staffs of technical workers whose duties are not closely connected with day-to-day operations but whose function it is to plan for generating plant additions and installations of new transmission and distribution equipment, supervise or inspect

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Electricians are the most numerous of the maintenance workers employed by utility systems.

the actual construction and installation, develop improved operating methods, and test the efficiency of the many types of electrical equipment. Electrical engineers are the key members of the technical staffs, and some mechanical and civil engineers are employed for special phases of the work. Large numbers of draftsmen are also employed. In most electric utilities, electrical engineers hold a large proportion of the top supervisory and administrative jobs. These men generally work their way up through the technical and operating divisions of the companies. Private utilities usually employ a number of engineers in sales development work whose job it is to aid industrial and commercial customers in their utilization of electrical equipment and lighting. They stimulate greater consumption of electricity by demonstrating the advantages of electrical equipment and suggesting places where more electricity can be effectively used.

After running through the various types of jobs it is apparent that the workers in electric light and power operations fall into two general classes—those whose jobs are distinctively electrical, in that they are found only or mainly in electric utilities, such as the power plant workers and the linemen; and those whose jobs are commonly found in other industries, such as the maintenance, commercial, and administrative employees.

Opportunities for Women

Only a few women are employed in the operating or maintenance departments of electric utilities, and these are mostly in clerical jobs connected with operations. A large proportion of the office employees in the administrative and commercial departments are women, holding such jobs as bookkeeper, cashier, typist, and clerk.

A special type of job opportunity for women is provided by some utility systems, which have staffs of women engaged in home service activities. These women perform such jobs as going into homes to advise women on the use of electrical appliances, and giving lectures to clubs and other groups of women on the use of appliances, cooking, planning of menus, and similar subjects. Part of the home economics staff may be assigned to work in special kitchens maintained by the utility, testing the equipment and developing and testing recipes.

Where the Jobs are Found

Electric utility service now reaches into almost every locality. Thus electric utility job openings occur in small towns as well as large,

Utility systems employ large numbers of office workers for administrative and commercial operations. This picture shows the accounting department of a large utility company.

and in rural regions as well as urban, and in the North, South, East, and West. While the employment is widely scattered, most of the jobs are still in the more heavily populated areas, especially where industrialization is extensive. Large cities also have a disproportionately large share, not only because they contain many customers, including large industrial users, but because the headquarters of most of the large systems are in the cities. The percent that each State had of the total electric light and power employment in 1940 is shown on the following page. Recently, the rapid extension of electric service into rural areas has brought more jobs into the smaller towns in farming sections, and Federal hydroelectric projects have opened up some new jobs in relatively isolated areas.

Working Conditions and Hazards

What a worker's job is like depends pretty much on what part of the system he is in. The office jobs are of course similar to office work in other fields, as far as the work surroundings go. It is mainly in the generating plants and in the transmission and distribution departments that we find the distinctively electrical jobs. There are considerable differences in the working conditions among the various types of jobs. These are described in later sections of this bulletin which summarize the information for each occupation.

In certain occupations in the power and light industry dangers of accidents resulting in injury or death are always present. Yet the frequency of accidents per man-hour worked is much lower than in most manufacturing industries. In 1947 there were about 16 disabling injuries among the employees of electric utility systems for each million man-hours worked, while the average rate in manufacturing industries was about 20 injuries. Though the injury rate is not high, when injuries do occur they may be serious. Fatalities are not frequent, but a larger percentage of the injuries result in death than in most other industries. Accidents are most frequent among line crews and cable splicing crews. Among the more frequent causes of these injuries are falls from poles and towers, blows from falling or flying objects, electrical shock and electrocution, accidents caused by tools, and motor vehicle accidents. Around the generating plant and substations failure to observe safety regulations while around high voltage lines and equipment may end in death. These accidents, however, are not common. Because of the dangers of electrocution and other hazards, the electric companies have made intensive efforts to enforce safe working practices. Accidents are usually due to carelessness rather than to defective equipment. Workers may lose their jobs for not following safety regulations.

Conditions of Employment

Not many industries offer the worker as much security of employment as does the power and light industry. Electric utility companies are not as likely to slash pay rolls in business depressions as most industries, because the demands for power hold up fairly well in such periods. There is little variation in employment between seasons of the year. Most utility workers are covered by pension systems, since the majority of the larger companies have them. A large number of the companies also protect the worker against sickness and accident with benefit provisions and insurance. Over half of the utility systems have paid sick leave plans covering both plant and office workers. The steadiness of utility employment is shown by the large numbers of workers who have been with the same company for more than 20 or 30 years.

Among other advantages of employment in this industry are moderate hours and annual vacations with pay. The 40-hour week is the normal workweek throughout the industry and 2-week vacations with pay are the general practice.

Earnings

Hourly earnings in this industry are higher than in most other public utility and manufacturing industries, but they are considerably lower than earnings in such high-paying industries as automobile manufacturing and petroleum refining. In March 1948, employees of the privately owned electric utility companies,

Electric utility jobs are found in every section of the country, but 7 States have over half of the workers

Percentage distribution of electric light and power employment, by region and State, 1940

Region and State	Percent of total	Region and State	Percent of total
United States	100.0	South Atlantic—Continued	
New England	6.8	Virginia	1.5
Maine	.7	West Virginia	1.2
New Hampshire	.5	North Carolina	1.6
Vermont	.3	South Carolina	.7
Massachusetts	3.5	Georgia	1.4
Rhode Island	.6	Florida	1.2
Connecticut	1.2	East South Central	4.2
Middle Atlantic	28.9	Kentucky	1.0
New York	15.4	Tennessee	1.4
New Jersey	5.2	Alabama	1.2
Pennsylvania	8.3	Mississippi	.6
East North Central	22.3	West South Central	6.0
Ohio	5.7	Arkansas	.6
Indiana	2.6	Louisiana	.9
Illinois	7.2	Oklahoma	.9
Michigan	4.8	Texas	3.6
Wisconsin	2.0	Mountain	3.2
West North Central	8.4	Montana	.5
Minnesota	1.7	Idaho	.4
Iowa	1.6	Wyoming	.2
Missouri	2.3	Colorado	.8
North Dakota	.3	New Mexico	.2
South Dakota	.3	Arizona	.4
Nebraska	.9	Utah	.5
Kansas	1.3	Nevada	.2
South Atlantic	10.2	Pacific	10.0
Delaware	.2	Washington	1.7
Maryland	1.9	Oregon	1.1
District of Columbia	.5	California	7.2

Source: Sixteenth Census of the United States, 1940.

which each month report their employment and pay rolls to the Bureau of Labor Statistics, averaged 140.8 cents an hour. This average included premium pay for work in excess of 40 hours a week, and any pay differentials for night shifts. In comparison, the 1939 average was 86.9 cents an hour, while the highest peak reached during the war years was 114.6 cents an hour in July 1945.

Within the industry, several factors influence wage rates paid by individual companies, such as the size of the system and its geographic location. According to a special wage survey made by the Bureau of Labor Statistics in March and April 1948, the larger systems generally paid higher wages than smaller companies. Geographically the highest wage rates were found in the Pacific Coast States, the second best pay area being the Great Lakes region. In general the lowest wage scales were in the southeastern section of the country.

There are also considerable differences between individual occupations in the pay received. Load dispatchers earned the most, with an average of $1.94 an hour. Watch engineers with $1.81 an hour were the next highest paid, followed by the electricians engaged in maintenance and repair work, who made $1.64 an hour.

The national averages for each occupation are significant, but in choosing a job the pay earned in particular regions or localities is of equal interest. Table 1 presents both the national and regional average earnings for the operating, maintenance, and clerical workers covered by the survey.

Unions

Approximately 90 percent of the workers in the privately owned electric light and power industry in 1948 were covered by union contracts. The most important of the unions in the field is the International Brotherhood of Electrical Workers (AFL), which has over 75 percent of the unionized workers. The Utility Workers Union of America (CIO) and a number of independent, unaffiliated unions also represent large numbers of workers. The larger electric utility companies are generally organized to a greater extent than the smaller companies.

TABLE 1.—*Average hourly wage rates for selected occupations in the privately owned electric utilities*[1], *March–April 1948*

Occupation and sex	Average straight-time hourly rates in —									
	United States	New England	Middle Atlantic	Border States	South-east	Great Lakes	Middle West	South-west	Moun-tain	Pacific
Operating, maintenance, and service jobs, male:										
Auxiliary-equipment operators	$1.35	$1.33	$1.39	$1.25	$1.12	$1.41	$1.23	$1.22	$1.27	$1.69
Boiler operators	1.48	1.45	1.49	1.57	1.36	1.60	1.30	1.37	1.34	1.60
District representatives	1.37	1.34	1.54	1.13	1.26	1.53	1.23	1.59	1.68	1.61
Electricians, maintenance	1.64	1.61	1.55	1.57	1.48	1.70	1.67	1.60	1.58	1.91
Groundmen	1.07	1.15	1.07	1.01	.91	1.13	1.00	1.00	1.12	1.38
Guards	1.24	1.22	1.23	1.27	.96	1.32	—	.97	1.14	(2)
Janitors	1.04	1.11	1.07	.94	.73	1.13	.91	.82	1.00	1.21
Linemen, journeymen	1.61	1.59	1.59	1.50	1.47	1.63	1.48	1.58	1.61	1.87
Load dispatchers	1.94	2.16	1.97	1.91	1.76	2.00	1.71	1.68	1.70	2.16
Machinists, maintenance	1.63	1.66	1.54	1.48	1.54	1.75	1.57	1.57	1.52	1.85
Maintenance men, general utility	1.45	1.57	1.48	1.35	1.45	1.49	1.29	.99	1.48	1.54
Mechanics, automotive	1.52	1.43	1.52	1.44	1.43	1.53	1.51	1.42	1.49	1.75
Mechanics, maintenance	1.53	1.57	1.50	1.63	1.42	1.56	1.42	1.53	1.54	1.68
Metermen, class A	1.59	1.53	1.61	1.65	1.46	1.60	1.53	1.58	1.55	1.87
Metermen, class B	1.36	1.32	1.36	1.36	1.20	1.41	1.31	1.18	1.33	1.68
Meter readers	1.18	1.15	1.15	1.22	1.08	1.21	1.13	1.09	1.13	1.35
Patrolmen	1.43	1.33	1.45	1.56	1.40	1.35	1.49	1.17	1.24	1.70
Servicemen, appliance	1.45	1.42	1.39	1.34	1.40	1.49	1.39	1.40	1.35	1.66
Stock clerks	1.24	1.23	1.21	1.30	1.26	1.28	1.17	1.02	1.20	1.49
Substation operators	1.53	1.51	1.49	1.53	1.19	1.64	1.49	1.23	1.47	1.69
Switchboard operators, class A	1.60	1.49	1.66	1.54	1.39	1.73	1.47	1.53	1.56	1.76
Switchboard operators, class B	1.37	1.30	1.40	1.35	1.11	1.37	1.38	1.29	1.16	1.75
Troublemen	1.63	1.76	1.69	1.60	1.57	1.62	1.55	1.49	1.62	1.87
Truck drivers	1.32	1.32	1.40	1.13	1.04	1.37	1.30	1.12	1.31	1.51
Truck-driver-groundmen	1.26	1.34	1.29	1.07	1.10	1.30	1.18	1.25	1.18	1.54
Turbine operators	1.49	1.45	1.47	1.33	1.38	1.61	1.36	1.45	1.59	1.68
Watch engineers	1.81	1.89	1.92	1.96	1.57	1.93	1.63	1.66	1.61	1.83
Watchmen	1.07	1.18	1.06	.93	.89	1.20	1.08	.90	1.04	1.20
Clerical jobs, male:										
Bookkeepers, hand	1.64	1.69	1.99	1.67	1.61	1.62	1.25	1.62	1.50	1.92
Clerks, accounting	1.36	1.23	1.52	1.21	1.27	1.38	1.05	1.21	1.34	1.61
Clerks, general	1.28	1.41	1.35	(2)	1.20	1.26	1.06	1.20	1.33	1.56
Clerical jobs, female:										
Billing machine operators	1.02	1.03	1.13	1.04	.96	.96	.89	.97	.97	1.27
Cashiers	.97	1.01	1.01	.86	.97	1.10	.74	.92	.95	1.29
Clerks, accounting	1.23	1.02	1.27	.94	1.07	1.65	.80	1.12	1.15	1.44
Clerks, general	1.03	1.22	1.03	.90	1.02	.96	.85	.92	1.39	1.24
Clerks, pay-roll	1.17	1.15	1.13	1.18	1.07	1.21	.94	1.18	1.16	1.46
Clerk-typists	.92	.91	.91	.87	.82	.94	.77	.82	.85	1.28
Stenographers, general	1.05	1.07	1.03	1.00	1.05	1.07	.97	1.01	1.10	1.26
Switchboard operators	1.06	1.06	1.12	.96	.95	1.05	.90	.92	.94	1.30
Typists, class A	1.13	1.02	1.31	.97	1.18	1.05	(2)	.95	1.07	1.25

[1] Excludes workers in systems with less than 100 employees. Averages shown are straight-time hourly earnings excluding premium pay for overtime and night work.

[2] Insufficient number of workers to justify presentation of an average.

Source: Wage Structure, Electric and Gas Utilities, 1948 (mimeographed), Division of Wage Analysis, Bureau of Labor Statistics.

Outlook for Employment in Electric Utilities

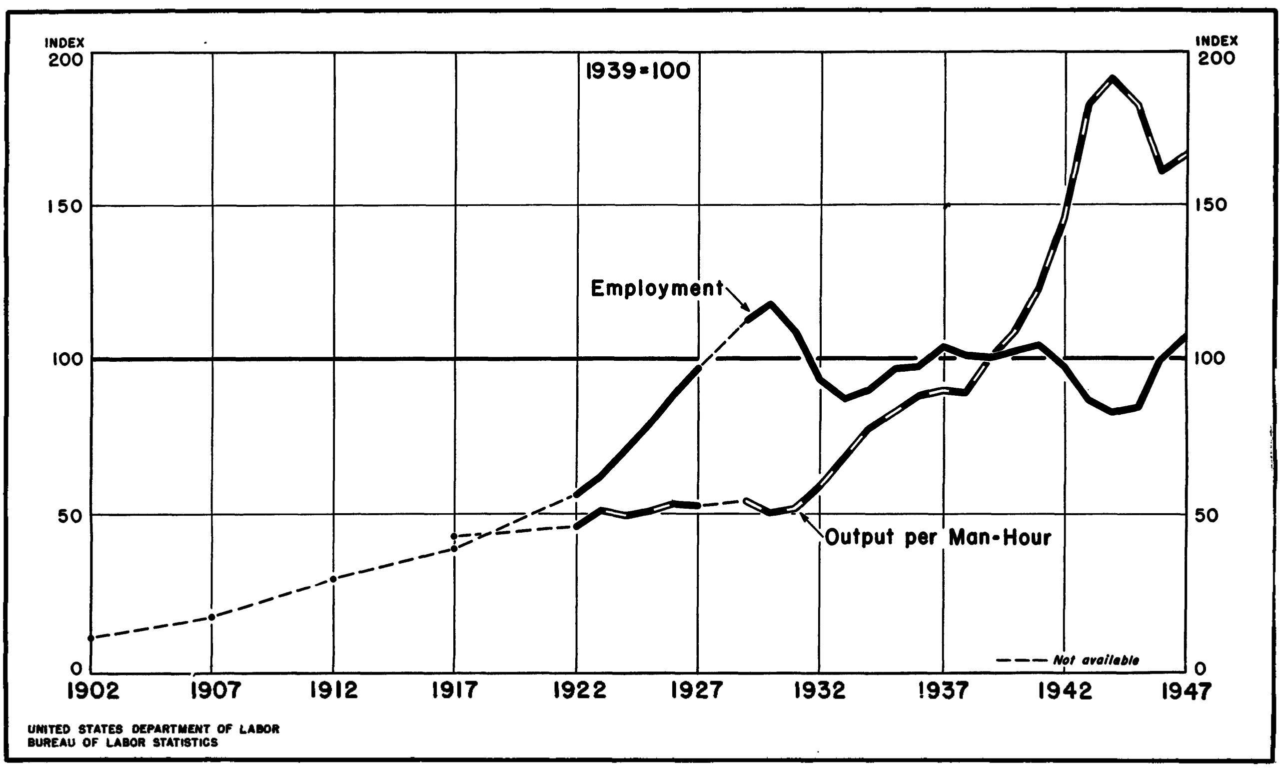
Past Trends—Production and Employment

An examination of the development of an industry—how it got started, the way it grew, and the place it has attained in the economy—reveals much about the factors which caused it to grow. This is important in considering the future possibilities of growth, since the future effects of these factors can be evaluated and related to expectations of economic change. For example, when we can measure the past effects of increasing population upon the demands for a product, we can apply what we know about future population trends to help appraise the outlook.

Early Years of the Industry

Although Faraday invented the electric generator in 1832, it was not until 1882 that there was an electric utility system distributing electricity from a central power plant. Before Edison's Pearl Street generating station, which served only a few hundred customers within a mile or so in New York City, began operating, electricity had been used only where it was made. The success of the first system encouraged the establishment of similar ones in other localities, and by 1902 there were over 3,000 systems in operation.

Chart 3.—Employment and output per man-hour in privately owned electric utilities



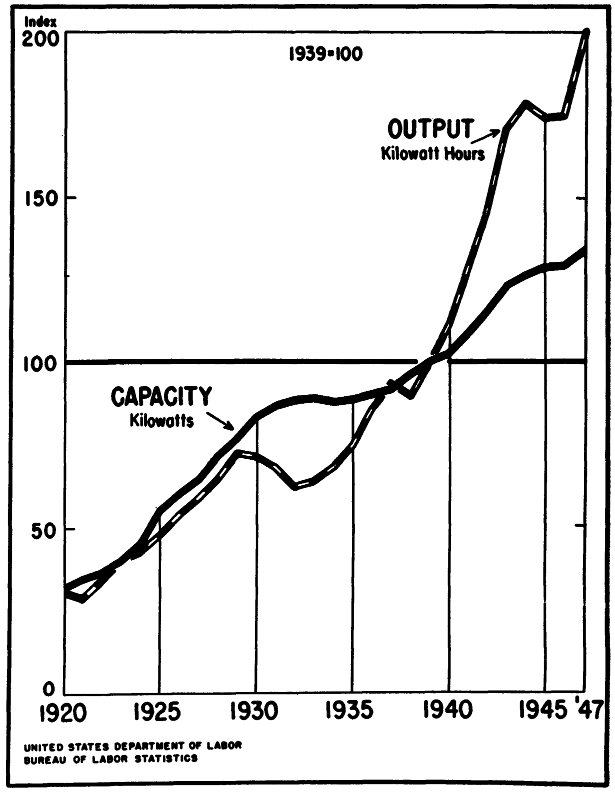
The first systems were usually quite small and served only limited areas because of technical difficulties in distributing electric power. The introduction of alternating current generators and improved transformers during the 1890's enabled the wider distribution of electric energy. The adoption of the steam turbine and the building of larger generating plants beginning about 1905 contributed to a significant increase in the efficiency of power plant operations. The output of the early systems had been used mainly for lighting, but the rapid introduction of the electric motor into the Nation's factories between 1900 and 1915 soon made industrial plants the largest users of electric power.

Between 1902 and 1917 the growing demands for electricity caused the capacity of utility systems to be expanded from 1,200,000 kilowatts to 9 million kilowatts. Over the same period, output was increased 10-fold, rising from 2½ billion kilowatt-hours to more than 25 billion. Chart 3 shows the large increase in the number of electric utility employees. Employment in private systems grew from 27,000 in 1902 to 95,000 in 1917, while the number of workers in municipally operated systems rose from 3,400 to almost 11,000. The increasing efficiency of utility operations is revealed by the relatively larger expansion of output than employment.

Great Expansion During the Twenties

The urgent demands for electricity during World War I helped to demonstrate the great potential market for electric service. Beginning in 1920 the electric power industry embarked on a vast expansion program that carried through until the depression of the 1930's and more than doubled its capacity. At the end of 1920 total utility capacity, including both privately and publicly owned plants, amounted to almost 13 million kilowatts. By 1925, as chart 4 shows, capacity had been raised substantially. In that year it was 21,500,000 kilowatts and in 1931 it reached 33,700,000 kilowatts. With these additions total capacity had increased more than 25-fold since 1902. During the 20's, output of utility systems kept pace fairly well with the growth in generating capacity, increasing from 39 billion kilowatt-hours in 1920 to 92 billion in 1929.

Chart 4.—Rapidly rising capacity and production show growth of electric utilities



To operate their additional capacity and carry on the greatly expanded production the electric light and power companies added employees to their pay rolls at a record rate during the 1920's. Employment in privately owned systems was 71,400 in 1912 and rose to 94,700 in 1917. By 1922 the companies employed 136,100 workers, but the big expansion was yet to come. Between 1922 and 1927, as the steep line on chart 3 shows, employment in the private electric power industry jumped by almost 100,000 to a new high figure of 234,700. The number of jobs continued to grow at about the same rate until an average of 288,000 were on the pay rolls in 1930. Employment hit 297,000 in the highest month of that year, a peak that has not again been reached.

Many of the additional employees were engaged in planning for new facilities or in the actual construction of new generating plants, substations, and power lines. A good share of the newly hired workers also were taken on to operate and maintain the added equipment. Another important cause of the large increase in employment was the enlarged administrative, technical, planning, and commercial activities of the companies, which resulted in greater needs for salaried employees. More than 45,000 salaried employees were added to the pay rolls of the private utility companies between 1922 and 1927.

While the private utilities were expanding their employment, the number of workers in the municipal systems was going up at a slower rate. Employment in these local systems jumped from about 11,000 in 1917 to about 15,000 in 1922. Between 1922 and 1927, a period when employment in the private companies was gaining most rapidly, the municipal systems added only 1,600 workers.

Gains in the Thirties Despite Depression

Along with practically every other industry, the electric utility field was hit by the great business depression which began in 1930. The forces behind the rapid growth of the industry were so strong however that even in 1932, the bottom of the depression, the decline in the output of current was relatively small. By 1935, as chart 4 shows, the total kilowatt-hours generated exceeded the previous peak which occurred in 1929. The yearly output continued to gain steadily during the rest of the decade except for a slight drop in 1938. Total generating capacity remained virtually stationary until the late thirties when the utility systems began again to add some new facilities.

The upward trend in the demands for current in the face of depressed industrial conditions and low incomes was, to a large extent, the result of the continued development of new uses for electricity and the wider adoption of existing uses. The average number of kilowatt-hours used by residential customers increased sharply during this period—largely because more and more electrical household appliances were going into the Nation's homes. Industrial plants striving for more efficient production were installing additional electrical powered machinery and electrical control equipment. The use of electricity in metallurgical processes such as steel making and aluminum refining was steadily growing.

Even though the demands for electricity were not substantially reduced during the depression, employment in the light and power industry was hard hit, falling from an average of 288,000 in 1930 to 212,000 in 1933. In the latter part of the decade, when output of current had exceeded the previous marks and was growing rapidly, the number of jobs still remained well below the 1930 level.

The failure of employment to keep pace with production showed that the companies had made substantial increases in output per worker during this period. These increases resulted to some extent from the low rate at which additional capacity was constructed during the period. Many utility employees in normal times are engaged in work connected with new facilities, such as planning, designing and supervision, and some are in actual construction work. A large share of the increased efficiency undoubtedly was obtained by a general tightening up of operations, and improved methods and equipment.

However, the electric utilities were able to increase their sales of current without proportionate increases in employment requirements partly because of the nature of their production operations. Utility systems can often generate and distribute fairly large additional quantities of current with only a few new workers. This is possible because so many of the utility jobs involve mainly controlling, watching, or maintaining equipment, and because equipment already in use can handle more output without many additional workers. Large numbers of additional employees are needed only when production capacity is expanded to take care of the increased demands for power.

Effects of World War II

Entry of the United States into the war in December 1941 found the electric utility sys-

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tems already affected by greatly increased demands for current. The defense boom of 1941 had brought an increase in output to 165 billion kilowatt-hours, compared with 128 billion in 1939. Capacity had already begun to be expanded in response to the general upward trend in consumption and totaled 42 million kilowatts by the end of 1941.

As the war production program grew in volume the industrial requirements for current were intensified. Besides powering the machines and lighting the factories, electricity is used in tremendous quantities in certain chemical and metallurgical processes essential to military production. The peak war production of the utilities was 228 billion kilowatt-hours in 1944, an increase of 38 percent over 1941 and 79 percent over 1939. Over two-thirds of the increase in power sales between 1939 and 1944 went to industrial plants.

Although considerable generating capacity was added to the utility systems during the war, the increase was on a relatively small scale considering the heavy demands for power upon the systems. The immediate nature of the demands, compared with the relatively long period it takes to plan, produce, and install new generating facilities, was one factor limiting expansion. The greater priority given to military equipment, whose production drew upon the same materials and manpower, also curtailed the possible increases in generating capacity. At the end of 1944, capacity totaled 49,200,000 kilowatts, an increase of about 7 million over 1941.

Although in some areas there was a strain upon the generating capacity, essential needs for electric power were largely met. Rationing of current was not put into effect, but nonessential uses were curtailed by orders which limited the hours of operation of certain types of businesses and restricted commercial lighting such as signs and store windows.

One important development which helped the industry meet the demands upon it, was a marked increase in the load factor. Put simply, this meant that use of power was spread more evenly over the 24 hours of the day. Utility capacity is planned to meet the highest total demands upon it at any one time. Total power demands fluctuate from hour to hour, with the peak demand on most systems now coming during the morning, though on some it occurs during the late afternoon or early evening.

During the war many industrial plants added second and third shifts, which used current in the late evening and early morning (before 7 a.m.). Since power demands and the percentage of generating capacity used are usually low during these hours, the consumption of the night-shift operations increased total production of current without requiring more capacity. Shifting electric power from one utility system to another to meet the varying peak demands of their consumers was done by providing more interconnection between systems. This method of efficiently utilizing the capacity available was important in filling the total power needs.

One of the most striking features of the utilities' successful effort to supply the wartime power requirements was that the great increases in output were achieved with substantially fewer workers than were employed in 1940. In 1944, the year of peak wartime output, employment in the private utilities was lower than it had been even in 1933, the bottom of the depression. Average employment in private utilities declined from 255,000 in 1941 to 211,000 in 1943 and 203,000 in 1944. Thousands of workers were lost to the armed forces and to war industries and replacements for them had to be trained. Utility systems were able to carry on with fewer employees partly by cutting to the bone all service functions not essential to actual operations. Sales departments were wiped out and planning staffs reassigned. Customers' meters were read every other month instead of monthly, saving labor time in reading meters and preparing bills. Hours were lengthened for most employees and all maintenance work that could be was postponed.

The companies were aided in increasing output with less labor by the higher load factor and by the normal ability of utilities to expand output over short periods without significant increases in employment. Much of the increased output went to large industrial plants, which require less labor per kilowatt-hour to supply than a large number of household users taking the same total amount of power.

The Early Postwar Period

The end of the war and the quick curtailment of military production brought a sharp drop in electric power consumption in the latter part of 1945, and output continued at levels considerably below the wartime peak during the first half of 1946. In the latter part of 1946, under the impetus of extremely favorable business conditions and high incomes, the trend of output began a swift climb which soon carried it above the wartime peaks. In 1947 total utility production amounted to 256 billion kilowatt-hours, compared to 222 billion in 1945. During the first half of 1948 output was running at a rate about 11 percent above 1947. During 1947 and 1948 demands for electricity were closely crowding generating capacity in many areas. Actual shortages of power occurred in some localities and appeared likely in others if the requirements of consumers continued to grow.

It rapidly became apparent that the long-run upward growth of utility power loads had resumed from where it left off at the peak of war needs, instead of dropping and then picking up again from prewar levels. To handle the prospective power needs a program of facilities expansion—including generating, transmission, and distribution equipment—was quickly begun by private and governmental utility systems. Although they were unable to add as much in 1947 as they had planned because it was difficult to obtain equipment, over 2 million kilowatts of generating equipment were installed.

Even before output began its postwar upsurge the electric utility companies had begun to rebuild their staffs to a size more in line with their level of operations. By July 1946 employment had risen to 247,000 from the 205,000 on the pay rolls at the end of the war in August 1945. Many thousands of those hired in this period were veterans returning to their jobs. During the rest of 1946 and through 1947 employment continued to rise. In December 1947 it stood at 269,000, and in June 1948 private utility employees numbered 279,000.

Future Demands for Electric Power

As the review of the growth and development of electric utilities shows, the use of electricity has become a basic part of our economic and household activities. Consequently the long-run trend of consumption is closely related to the levels of business and industrial activity, to changes in consumers' incomes, and to population growth. These are some of the major factors that will determine how much power will be required by industry at any given stage of technical development and how much electricity individuals will be able to buy.

The other part of the story of the demand for electric power is the introduction of new uses for electricity and the wider adoption of existing uses. This might occur, for example, through the development of new industrial equipment powered by electricity or of a new process using electric current. Also, when new industries arise they frequently add substantially to the demands for power. We are all familiar with the important place that electrical appliances occupy in American homes. But most households are far from using all the electrical products that have been developed already; and new types are sure to come.

The users of electricity can be divided into a number of groups, each of which requires electricity for certain special purposes. The nature of the future demands for electricity and an idea of the total demand can be best obtained by considering each of these groups separately, and by examining the factors that are going to determine its electric power requirements. The number of customers in each major group of consumers is shown in table 2, together with the total amount of power bought by them in 1947.

TABLE 2.—*Number of customers and amount of electric power purchased, by type of use, 1947*

Type of use	Customers (as of Dec. 31)		Power purchased, 1947	
	Number	Percent of total	Amount (in billions of kilowatt-hours)	Percent of total
All types of uses	38,431,950	100.0	217.6	100.0
Residential and rural	33,144,095	86.2	49.7	22.8
Industrial and commercial—				
Small users[1]	4,960,895	12.9	38.4	17.6
Large users[1]	191,363	.5	113.5	52.2
Street and highway lighting	28,976	.1	2.4	1.1
Street and interurban railways	138	([3])	4.5	2.1
Railroads	31	([3])	2.6	1.2
Miscellaneous[2]	106,452	.3	6.5	3.0

[1]The dividing point between small and large users is on a basis of 50 kilowatts of demand. (Demand means maximum capacity of an individual consumer to use current at any moment of time.)

[2]Includes certain governmental agencies such as airfields and army camps, and sales from one utility system to another.

[3]Less than 0.05 percent.

Source: Edison Electric Institute, Statistical Bulletin No. 15, 1948, New York, N. Y.

Industrial Demands

For many years industrial plants have accounted for over half of the power purchased from utilities. Electric power is basic to modern mass production methods and electricity has become essential in industrial operations.

Industrial plants use electric power in many different ways. The use that was first introduced of course was lighting, and consumption of current for lighting is still an important part of the total purchases of many industrial plants. The introduction of the electric motor and its widespread adoption in manufacturing operations soon made the use of electricity to drive motors the main requirement of industrial plants for current. In most plants today the use of electricity for this purpose is still the major part of the consumption. However, in some industries electricity is used principally in chemical and metallurgical processes. Other uses of electricity besides these three major ones include the operation of welding equipment, control devices, air-conditioning equipment, heating equipment used in certain processes, and elevators.

Many industrial plants do not buy electric power from utility systems but instead generate their own supply. This is especially true in several of the industries which make the greatest use of electricity and where electricity is a vital part of the process. In some plants electricity can be generated as a byproduct of the main operation. A good example is a steel mill, where steam is produced by heat obtained from other parts of the process. Therefore in evaluating the future demands of industries upon the utility systems, allowance must be made for the electric power that will be produced in the generating plants owned and operated by the individual manufacturing plants. In recent years industrial plants have tended to purchase an increasing percentage of their electricity requirements from the utility systems.

The major industrial users of electric power in 1946 were the chemicals, iron and steel, nonferrous metals, and paper industry groups. However, of these all except the nonferrous group generated a very considerable proportion of their total power requirements. Even in terms of purchased power however, the chemicals, iron and steel, and nonferrous metals groups were the major consumers in that year. Other important users were the food products, textiles, petroleum, machinery, automobiles, and rubber industry groups. Coal mining and metal mining were also heavy users of electric current. In all of the industry groups except iron and steel, chemicals, and nonferrous metals, most of the power consumed was used to run electric motors.

The future requirements for electric energy in factories depend largely upon the rates of activity in the major consuming industries and upon the wider introduction of labor saving machinery and improved processes. Among the newer industrial uses of electricity which promise increasing utilization of electricity are welding equipment, various types of electric furnaces, infrared heating, induction heating, and annealing. Other growing uses include X-ray equipment, inspecting and testing equipment, and devices which by electrostatic precipitation remove impurities from the air. Another use of electricity in industrial operations has been for air-conditioning equipment, especially in certain industries where controlled temperature and humidity are important to the process. This is true, for instance, in many textile plants and in the metalworking plants which do precision work. Much progress has also been made in improving factory lighting standards. New equipment developed in recent years has made much factory lighting obsolete. These are some of the growing uses from which greater electrical loads may be built up.

An important source of increased power requirements could be the use of electrically powered equipment in new industries or processes which may develop. Outstanding examples are the possible future large scale establishment of synthetic gasoline plants, and the potentially extensive use of electrically operated ore beneficiating equipment to eliminate impurities from low grade ores. Both of these processes would require very large quantities of electric current if used to any considerable extent.

Besides the influence on demands of the new and expanded uses of electricity in industrial processes we must also consider the future levels of operations in the industries themselves. Since 1940 activity in manufacturing and mining industries has been at very high levels, first because of the defense boom, later on because of the great demands of war production, and recently because of the general postwar prosperity. Sales of electrical energy to large industrial and commercial users increased from about 60 billion kilowatt-hours in 1940 to 113 billion in 1947. The 1947 total almost equaled the energy sold to industrial users in the peak war year 1944. Indications are that in 1948 industrial consumption will surpass the 1944 total. Planned increases in expenditures for certain military items, including aircraft, will undoubtedly help to sustain industrial production at high rates of activity in the next few years.

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Looking at the prospects for the principal industrial consumers of electric current, the chemicals, iron and steel, nonferrous metals, and paper industries all appear to have favorable short-run and long-term outlooks. Iron and steel capacity is being expanded, chemicals are in record peacetime demand, and there is a widespread shortage of paper products. The production of aluminum, which is one of the main users of electric energy, declined after the end of the war but has picked up again sharply, and indications are that in future years aluminum production may approach or exceed the wartime output. This is especially likely to happen if large scale aircraft production programs are put into effect.

Any prolonged business depression would of course have a dampening effect on industrial activity, but over the long run it appears likely that there will be a gradual but sustained increase in the activity in most industrial fields using electric power in large quantities. Temporary set-backs may well occur, however, in some industries in which the great postwar demands for production were at least partly the result of curtailed output during the war years.

Taking into account both the new uses for electricity in industrial processes and the favorable long-term economic outlook for the major industrial consumers, a sustained long-run increase in industrial consumption of electricity may be looked for. A good share of the increase is likely to come through new uses. In industries where electricity is used mainly for lighting and to run electric motors, increases will be dependent mainly upon the activity in the industries. The emerging of new industries and new types of production holds great hope for expanded electrical consumption.

Analysis of the future industrial needs for electricity by the market development department of Westinghouse Electric Corporation has resulted in an estimate that almost 200 billion kilowatt-hours will be consumed by large industrial and commercial users by 1957. Even if the trend of industrial use does not rise this sharply, it is clear that, given a continuation of the long-run increases in industrial activity, there will be substantial long-run increases in consumption of current by the Nation's factories.

Commercial Demands

The commercial market for electricity includes retail stores of all kinds; service establishments such as laundries, dry cleaning, and beauty parlors; amusement enterprises such as theaters or night clubs; and office buildings and other public buildings. As table 2 shows, in 1947 small commercial users (including some small industrial plants) accounted for about one-sixth of all the sales of electricity to final consumers. While sales of electrical energy to these consumers have been increasing continually since 1934, the greatest gain in consumption occurred between 1946 and 1947.

By far the principal use of electricity by commercial establishments is for various types of lighting. In addition to the standard lighting fixtures used to illuminate retail stores or offices, there is display lighting used in store windows, advertising signs, and theater marquees and for similar purposes. Electricity also finds other important uses in certain types of service establishments. For example, laundry equipment is powered by electric motors, electric cooking equipment is becoming increasingly utilized in restaurants, beauty parlors use drying machines, and in office buildings electric motors power the elevators. One of the most rapidly increasing uses of electricity in commercial establishments is the operation of air-conditioning and refrigeration equipment. Air conditioning is being used in more and more stores and offices as well as in theaters, and refrigeration equipment is important in restaurants and many retail and wholesale food establishments.

The outlook for increasing consumption of electric energy in the commercial field is very promising. Many of the new developments in lighting have not yet been applied in a large proportion of the commercial establishments. Installation of fluorescent lighting, with its greater efficiency in use of current, tends to hold down the consumption of electricity for lighting, but it is believed that this trend will be more than offset by the general acceptance of higher standards of lighting.

In the coming years air conditioning may become almost universal in stores and offices except in areas where temperatures and humidity conditions make it unnecessary. An example of the effects of air conditioning upon electricity requirements is the situation in Washington, D. C., where extensive use of this equipment in stores and offices has changed the peak period of electrical consumption from the wintertime to the summertime.

The Westinghouse forecast of sales to the small commercial and industrial users is not as optimistic as the one for heavy industry. Westinghouse analysts believe that kilowatt-hour consumption of this group in 1957 will be about 58 billion kilowatt-hours as compared to less than 40 billion in 1947. Since lighting costs are usually a small part of the cost of operation of stores and service establishments, it is reasonable to expect that when competition gets keener they will expand their use of electricity for such purposes as signs and more effective lighting. Thus a gradual but persistent rise in the consumption of electricity in commercial establishments can be looked forward to over the next 10 to 20 years.

Household and Farm Demands

Although the total quantity of electric current consumed by households and farms is less than the total industrial usage, they have at least as much influence as the industrial plants on the employment in the electric utility system. In total dollar value of sales of electricity, the household and farm consumers are the most important class of customer. Their purchases of current in 1947 amounted to $1,490,000,000—over 30 percent more than the sales to industrial firms.

Household and farm customers contributed such a large share of utility revenues because the average price they pay per kilowatt-hour is considerably higher than the rates paid by large industrial users. This difference in rates is caused mainly by the greater costs of serving the individual homes and farms; but it also reflects partly the better bargaining position of the large firms, which can make their own power if they want to. Comparing the 33 million homes and farms served, with the less than 200,000 large industrial and commercial users, gives some idea of why it costs more to sell a kilowatt-hour of electricity to the residential and rural customers. A good share of the greater cost of this service is labor cost—in installing and maintaining the distribution lines and in billing and collecting from the millions of individual users.

The number of new customers that will be added is an important factor in determining the future demands of residential and rural users for power. One source of new customers will be future population growth. The U. S. Bureau of the Census expects population to increase, but not as rapidly as in past years. According to a recent Census estimate the population in 1965 will be 169 million compared with less than 147 million in 1948.[1] This increase means a substantial gain in the number of families that will be consuming electricity.

Over 90 percent of all the nonfarm homes in existence are already served by electricity. Even if most of the remaining homes are wired in future years only a limited number of new customers would be added from this source. The large numbers of new dwelling units (houses and apartments) that will be constructed to take care of housing needs will provide most of the new residential users of electricity. The building of more than 900,000 units will have been started in 1948, and the next 10 years should see a continued large volume of housing construction if inflated prices or possible business slumps do not interfere. Bringing electricity to existing houses and to newly built dwellings should add considerably more than 5 million customers over the next 10 years.

Rapid progress is being made by both the rural cooperatives and private utility systems in electrifying the Nation's farms. It is likely that well over a million rural customers will be added in the next decade.

The trend of total demands of households and farms for electricity will be determined mainly, however, by changes in their average consumption. For many years there have been almost continuous yearly increases in the average number of kilowatt-hours used by homes and farms. In 1928 households were using an average of less than 500 kilowatt-hours in a year, while by 1947 they were consuming almost 1,400 kilowatt-hours in a year. This great gain in consumption was due primarily to the widespread introduction of many types of electrical appliances. In the early days of the electric light and power industry almost all of the domestic consumption of current was for lighting, but the general acceptance of appliances has changed the picture considerably. Lighting is still a very important factor, but over half of the typical household's use of current now goes to run various types of appliances.

Despite the rapid strides made in electrifying household operations there are still many possibilities for growth in the use of electrical appliances. Part of this growth should come through the introduction of new types of equipment, and the wider use of already established household aids will also stimulate a greater consumption of current. Surveys have shown that while almost every home has a radio and an electric iron large numbers of families still do not have such common appliances as vacuum cleaners and electric refrigerators. (Some of these families of course have gas refrigerators.)

For some other less widely used electric appliances there are even greater sales possibilities. Some of these, like electric cooking ranges and electric water heaters, must compete directly with units burning gas or other fuels. Other appliances, in service in some homes but with good chances of expanded use, include automatic washing machines, clothes driers, ironers, electric roasters, germicidal lamps, home freezers, dishwashers, garbage disposal units, ventilating fans, and electric blankets. The wider use of air-conditioning equipment in homes would also add considerably to household demands for electric power. Television is another new development increasing electric consumption. The number of sets now in use is relatively small, but big gains are predicted for the next several years.

[1]Source: Forecasts of the Population of the United States, 1945-75, U. S. Bureau of the Census.

Expansion in the use of electric water heaters and ranges could contribute heavily to an increase in total domestic use of electricity, because of their large consumption of current. A water heater in an average home requires about 3,500 kilowatt-hours for a year's operation, more than twice as much as the present average for total consumption per household. Electric ranges use over a thousand kilowatt-hours in a year. Sales of electric ranges have been growing rapidly in recent years. Future sales will depend partly on how many will be installed as replacements for gas ranges. The main competition on farms will come from stoves burning liquefied petroleum gas.

Certain types of household equipment that we usually do not think of in connection with electricity are relatively big users of current. Oil burners and coal stokers both require about 250 kilowatts per year, which is almost as much as the average annual consumption for home lighting.

A development that could revolutionize the household market for electricity would be the widespread adoption of electrical equipment for heating homes. One method of doing this is by using large sizes of ordinary space heaters (those which produce heat by sending a current through resistance coils). However, if electricity does become a common way of heating homes it may be through the introduction of the electrically operated heat pump, a device that is still in an experimental stage. Heat pumps also cool the house in summer. In the winter they draw heat out of the ground, the air, or stored water, such as in a well. In summer the operation is reversed, and the pump works like an ordinary electric refrigerator to cool the house. A complete system of heating and cooling, using the heat pump, would require about 10,000 kilowatt-hours per year for an average sized house. As yet, electric home heating methods have been used only to a limited extent, and only in areas where the climate is not severe. At present, electric heating costs are usually higher than those of other methods. This is the main obstacle to the large scale adoption of electric heating in homes.

The use of electricity on farms is just getting into full swing. Except for western farms, where large quantities of power are used for irrigation pumping, electricity was at first mainly used on farms for lighting and for operating small water pumps. In the last 10 years the advantages of electrically operated equipment for many farm activities have become apparent. The rural cooperatives sponsored by the Rural Electrification Administration have done much to encourage the use of electricity by farmers. Typical uses of electricity on the farm are for milking machines, cooling equipment, and heaters for brooders.

All the indications are for a continued sharp rise in the average amounts of current used by homes and farms. This will especially hold true if incomes remain high, enabling the purchase of additional appliances. Market analysts of the Westinghouse Electric Corporation look for average yearly residential consumption to increase to 2,400 kilowatt-hours and farm consumption to 4,000 kilowatt-hours by 1957. According to their estimates this would mean a total home and farm consumption of over 100 billion kilowatt-hours by 1957 as compared to the 50 billion used in 1947. Whether these estimates are high or low, a substantial increase in sales of electricity to these users is very probable, and unless present trends are radically changed their consumption should reach at least 80 billion kilowatt-hours a year by the end of the next decade.

Demands of Other Users

New improved equipment and higher standards of lighting should result in increased demands for current for street lighting. This use accounted for 1.1 percent of the total kilowatt-hours sold in 1947. Street and interurban railways, whose consumption of current had been declining for many years, stepped up their demands during the war. No significant increase is expected in this category however, and there may be a renewed decline if busses continue to replace street cars in transit operations.

Prospective Levels of Capacity and Output

Even a conservative appraisal of the future demands of the various classes of electricity users points to substantial increases during the next 10 years in the total electric power that must be generated. Surveys of future power requirements on the utility systems, made by different groups, support this conclusion. The staff of the Federal Power Commission (in July 1947) estimated that total electric power requirements in 1952 will be 326 billion kilowatt-hours, compared with the 256 billion kilowatt-hours generated in 1947. This estimate, which was based on an assumed increase of 1 percent a year in the Nation's labor force, would mean an increase in power produced of almost 30 percent over that period. The Market Development Department of the Westinghouse Electric Corporation has, as a result of its study of trends in power consumption, projected an annual total of well over 400 billion kilowatt-hours to be generated by 1957. This study indicated that total utility capacity should be raised to 95 million kilowatts by 1957 to meet the expected demands. An increase of this magnitude would mean almost a doubling of capacity within 10 years. Previously, utilities have more than doubled their capacity within 10-year periods, but never when the quantities involved were so great.

This estimate may turn out to have been too optimistic, but if present trends continue the total utility generation of current very likely will reach at least a level of between 360 and 400 billion kilowatt-hours by 10 years from now.

The utility systems, already pressed by the strong demands for power, are well aware of the possible growth in the requirements upon them. Two surveys of projected facilities expansions show the tremendous volume of additions to capacity already planned by the utility systems.

In June 1948, class I utility systems (those which produce more than 50 million kilowatt-hours a year) reported to the Federal Power Commission that they had added 1,529,811 kilowatts of capacity during the first half of the year and had scheduled additions amounting to more than 15½ million kilowatts to be installed between July 1948 and the end of 1951. Since these systems had 49.4 million kilowatts of capacity in December 1947, this would be a total increase of almost 35 percent for the period 1948-51. Assuming that the smaller systems increase their capacity at the same rate, total utility capacity would amount to over 70 million kilowatts by the end of 1951.

A survey of utility expansion plans released in October 1948 by the Edison Electric Institute showed that systems intend to add over 26 million kilowatts of generating capacity in the period from the beginning of 1948 to the end of 1953. This would bring total capacity to over 78 million kilowatts by 1953.

Since both of these surveys represent the definite plans of utility systems, they provide a reliable indication of the minimum increase in capacity that can be expected over the next 10 years. Even allowing for a substantial decrease in the rate of utility construction after 1953, it appears likely that total capacity will at least fall within the range of 80 to 85 million kilowatts by the end of the coming decade, or 53 to 63 percent more than on January 1, 1948.

Effects of Technological Changes on Labor Requirements

Throughout most of its history the growth of the electrical utility field has been accompanied by marked increases in efficiency as measured by output per worker. For example, during its early years the private electric light and power industry increased its output much faster than its employment. The only period in which output per man-hour did not rise was during the twenties, when utility capacity was being greatly expanded. As chart 3 shows, output per man-hour climbed rapidly in the 1930's until by 1940 it was more than double the 1930 ratio. The feat of the private utilities in boosting their generation of power by over 60 percent during the war, while absorbing a 20-percent drop in employment, is reflected by the sharp rise in the Bureau of Labor Statistics index of output per man-hour to a high point 91 percent above the 1939 base. When the utilities began to rebuild their staffs after the end of the war, output per man-hour declined in 1946, but it rose again somewhat during 1947. The extent to which the past increases in efficiency of production will continue into the coming years will be as important as the prospective capacity and production levels in determining the future employment needs of utilities.

There are several factors behind the industry's achievement of continually raising its generation and distribution of power without comparable increases in labor requirements. The most important has been the introduction of improved and larger equipment. The industry has always striven to make its production and distribution operations as automatic as possible. Also, after a system is well established in its operations, it can add facilities and step up its output without proportionate increases in its employment.

These and similar developments will continue to have a major share in determining how many new workers will be needed for the prospective utility expansion. Most of the new generating plants will be larger than the average ones now in use, and the larger power plants require far fewer employees per unit of output. The new plants will have the latest features and modern lay-out which tend to reduce employment needed in the plant to a minimum, such as centralized control of operations. New equipment installed for transmission and distribution of power is generally more trouble-free and flexible than the older types, requiring less maintenance work and line work.

Since much of the increased output will go to present customers rather than to new ones, in many areas it will be mainly necessary to revamp and raise the power-carrying ability of the transmission lines and distribution systems, rather than to construct completely new lines. There will not be a proportionate increase in meter reading, billing, and other activities which are related to the number of customers. As a result of these and similar conditions, the utility systems should again be able to expand output with a relatively smaller increase in employment.

Development of Atomic Energy

There has been considerable discussion and speculation about the technological and economic effects of the development of atomic energy upon the electric power industry. The prospective use of atomic energy for power generation will have a far reaching influence on the design and location of power plants and on the utilization of fuel by the electric utilities. It is likely, however, to have relatively little effect on the number and kinds of jobs in the industry. As the process of making electricity from atomic energy is now visualized, heat obtained from an atomic pile would be used to make steam which would drive the turbines. Thus the principal difference in operating method from an ordinary steam power plant would be in the source of heat for the boilers. The main effect of the use of the uranium or other fissionable material would be its substitution for coal or oil. From the production of the steam on through the rest of the operations, the process would be the same as that now carried on by utility systems.

A power plant using atomic fuel would however require many protective features to guard the workers and the equipment against the effects of radiation. When atomic energy generating plants come into general use they may have considerable influence on location of power plants. Because the quantity of atomic fuel needed to run a power plant would be considerably less bulky than the amount of coal required, it should be possible to set up generating plants at some locations where water power is not available and where it is costly to transport coal. A pound of atomic fuel such as uranium will equal the energy output of thousands of pounds of coal.

If the present system of control over the development of atomic energy is continued, it is likely that atomic-fueled generating plants would be operated either by the Federal Government or by government licensed organizations and that the power produced would be sold to utility systems for transmission and distribution.

Estimates vary as to how soon generating plants powered by atomic energy will be in regular commercial use. The Atomic Energy Commission in its Fourth Semiannual Report, issued in July 1948, indicated that it does not look forward to large scale operation of atomic power plants before 20 years. Experimental power plants sponsored by the Atomic Energy Commission will be in operation within a few years, but many years of research and experimentation will be required to make feasible atomic power production in connection with regular utility operations.

Future Trend of Employment

If the utility systems expand their capacity and output as much as expected, a large number of additional workers will be required. However, as pointed out in the discussion of technological trends, the increase in employment will be relatively less than the gain in output. All these factors considered, it seems reasonable to conclude that by 10 years from now (by 1958) total utility employment will range between 375,000 and 390,000. This would mean an increase of 45 to 60 thousand—or 14 to 18 percent—over the 330,000 workers employed in June 1948. Most of this increase can be expected in the privately owned systems.

The estimated total increase gives but a general picture of the trend. There will be variations in the amount of increase among the different occupational groups. In considering the career possibilities in the electric light and power field it is necessary therefore to examine the opportunities in the individual occupations.

Major Electric Light and Power Occupations —

Employment Outlook, Earnings, Duties, Training, Qualifications

Electrical Engineers

For anyone considering a career in the electric light and power field, electrical engineering training offers one of the best means of entrance and advancement. Although not the most numerous workers, electrical engineers are by far the most important. Because of the highly technical nature of utility operations and because of the heavy reliance on equipment, electrical engineers hold a bigger percentage of the jobs in electric utilities than in any other industry. Not only do engineers carry on the technical operations, but they occupy a good share of the administrative and planning positions. About 16,000 electrical engineers were employed by electric utility systems in 1948, but not all were in jobs that would be considered as straight engineering jobs.

Duties

The electrical engineers actually functioning in engineering jobs in utility systems have a wide variety of jobs. Some do work that is closely related to day-to-day operations, such as direct supervision or checking the actual operation of the power plants, or making tests on the transmission and distribution systems. A large number of the engineers, however, are concerned with the growth and development of the systems. This includes planning for additions to the generating and distribution facilities, supervising construction, and directing installation of new equipment.

Examples of typical engineering jobs will best illustrate the role of the engineer in planning and carrying out changes in a utility system. Some engineers are assigned to study the size and nature of the future demands upon a utility company for power. The results of their work often lead to recommendations for construction of new plants, substations, and transmission lines. Or their studies indicate changes that should be made in the company's distribution system, such as raising the capacity of a power line serving a growing neighborhood.

Whenever changes are made in the generating and distribution facilities of a utility system, there are decisions and problems which call for engineering knowledge. For this reason utilities employ engineers who specialize in planning and directing the installation of generating, transmission, and distribution equipment. For example, if a company decides that it must build a substation, engineers will be called upon to choose a suitable location with regard to connections with the rest of the system, to decide what types of equipment should be put into the station and what its capacity should be, and to plan an efficient lay-out for the station. Engineers employed by utilities seldom design individual units of equipment: equipment of standard manufacture is usually installed. However considerable engineering knowledge is required to select, from among the various products available, the most efficient equipment for the particular project. Engineers must keep themselves accurately informed on trends in design and performance of the equipment on which they specialize.

Many engineers are employed by utility systems for testing work. This involves testing and checking new equipment before it is put into service, and equipment which has been repaired or overhauled before it is returned to operation.

Engineers are needed not only for major expansion of the systems; even minor changes in the lay-out of a distribution line to give better service to a neighborhood, require electrical engineers to prepare the plans.

In addition to the engineering jobs in operating, planning, and testing, many of the key positions in the administrative and commercial activities are filled by men with electrical engineering training. Supervision and administration of most departments other than accounting, financial, and legal is commonly handled by electrical engineers. Many engineers are employed in sales activities. Lighting engineers, for example, show customers how they can more effectively light their stores or factories and advise them on the installation of lighting equipment. Industrial application engineers try to get industrial firms to buy power from the electric company rather than to generate their own supply. Other engineers contribute to the determining of company policies such as the rate engineers, who make combined engineering-economic studies to guide the company in setting its rates to the different classes of customers.

Training and Qualifications

Virtually all new electrical engineers hired by utility companies must have completed at least a 4-year college course in electrical engineering. In the past it was possible for men without college degrees to become engineers by gaining practical experience and taking some courses, and some of the engineers working for utilities qualified in this way. In recent years, however, systems have increasingly adopted the practice of taking on only graduate engineers. Some of the positions in research and design require graduate study in addition to the completion of the basic 4-year engineering course.

During the first 2 years of engineering training in most colleges, the curriculum consists mainly of basic studies such as mathematics and physics and nontechnical courses such as English composition. In the last 2 years electrical engineering students concentrate on engineering subjects, including such courses as electrical theory, alternating current circuits, and electronics.

Employment Outlook

During the next 10 years there will be a fairly large number of openings for electrical engineering graduates in electric utility systems. The systems, including both private and public, can be expected to hire between 1,500 and 2,000 additional electrical engineers. This estimate is based upon the projected expansion program of the utilities. However most systems will be able to enlarge their facilities and boost their output without proportionately increasing their engineering staffs. Besides the additional engineering jobs that will be created, about 3,000 electrical engineers must be hired to replace those who will die or retire in this period, and a large number of other vacancies will occur because of engineers transferring to other industries.

The additional engineers taken on by utilities will be needed mainly for the large scale expansion of facilities—both in planning and constructing the original installations and in keeping them efficient and up to date after they are in operation. Utilities are also likely to intensify their sales efforts to ensure that the additional capacity will be fully utilized, and this will mean greater utilization of engineers in sales positions. Along with this there should be increased emphasis on engineering services to customers.

The number of additional jobs for engineers will vary considerably among different sections of the country and different utility systems. In general the greatest opportunities will occur in areas where the greatest expansion of facilities is planned. These include many rapidly growing western areas and also sections in other parts of the country where rural demands have been sharply increased or where there has been recent growth in the areas surrounding large cities. On the other hand some companies which plan to expand their operations, but on a smaller scale, believe that they can increase their capacity and their total employment without adding proportionately to their engineering staffs.

Privately owned utilities will have a large part of the job openings for electrical engineers, because they account for the bulk of utility employment. There will also be many opportunities for electrical engineers in connection with the utility operations of Federal agencies such as the Department of the Interior, in municipal systems and in the rural cooperatives sponsored by the Rural Electrification Administration.

A large part of the electrical engineers in utilities are in the age groups where increasing numbers drop out because of death or retirement. In the next 10 years it is expected that about 3,000 electrical engineers will leave utility employment for these reasons.[2] Replacement of these men will be a major part of the electric utility hiring of engineers in the coming decade. The number of vacancies resulting from men transferring to other industries cannot be estimated because it depends upon such factors as the opportunities that will exist in the other fields which use electrical engineers.

Although there will be many openings for electrical engineers in the next 10 years, there may also be many applicants for these jobs. The Nation's engineering schools are turning out electrical engineers at the highest rate in history. It is estimated on the basis of current enrollments that almost 13,000 electrical engineers will be graduated in 1950 alone.[3]

Earnings

Earnings of engineers increase with length of experience and also vary with the kind of work they do, the level of education they have attained, and the industry and locality in which they are employed. According to a survey made by the Bureau in 1946, median monthly salaries of electrical engineers in all industries were $237 for those with 1 year of experience, increasing to $315 for those with 5 years, $366 for 9 to 11 years, and $502 for 25 to 29 years. Those with a master's degree in engineering earned on the average about $45 more a month than the much greater number with a bachelor's degree; the small number with doctor's degrees earned considerably more than the bachelors. The higher average earnings of the men with more experience in the profession are due largely to the fact that many of them have moved up to administrative jobs.

In the electric utility industry, 10 percent of the engineers earned less than $245 a month (these were mostly the younger engineers) and the top 10 percent—mostly those with many years of experience who had attained administrative positions—earned more than $630 a month. The median for all electrical engineers in utilities was about $370 a month—somewhat less than the averages paid in electrical machinery manufacturing and the communications industries, the two other major fields for electrical engineers.

Other Technical Workers

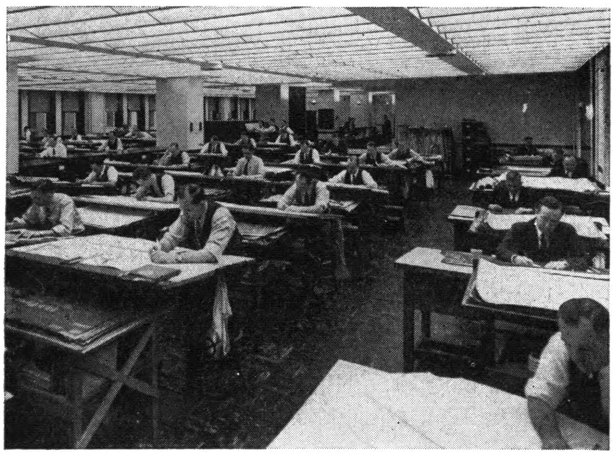
In addition to the electrical engineers, other technical specialists are employed by utility companies. Mechanical engineers are particularly important in the operation and design of steam generating plants. The major operat-

[2]Estimated on the basis of preliminary tables of Working Life Expectancy prepared by the Occupational Outlook Service.

[3]Persons interested in electrical engineering as a career may wish to consider also the opportunities for the profession in other industries. A more complete discussion of the outlook for electrical engineers will be presented in a forthcoming bulletin covering the entire engineering profession.

ing problem in steam generating plants is getting a high output of electricity per pound of fuel. This requires mechanical engineering knowledge, and consequently the superintendent of a large generating plant is apt to be a mechanical engineer. Civil engineers are needed to plan and supervise construction work. Large numbers of draftsmen are also employed in the engineering departments of utility systems to prepare engineering drawings and blueprints.

In view of the expected large construction program, there should be relatively good job opportunities in utility systems for these technical workers during the next 10 years.



Draftsmen preparing engineering drawings and blueprints in the engineering department of a utility system.

Jobs in the Power Plant

The most numerous and important of the generating plant workers are the four classes of power plant operators—the boiler operators, turbine operators, auxiliary equipment operators, and switchboard operators. They are the core of the power plant staff. Supervision of the operations is handled by the chief engineer in charge of the plant and by the watch engineers under him. At the other end of the scale are the laborers and helpers who assist the power plant operators.

In April 1948, utility systems (including both private and publicly owned) employed about 5,700 boiler operators, 4,000 turbine operators, 5,000 auxiliary equipment operators, 5,200 switchboard operators, and 2,200 watch engineers. A substantial number of power plant workers are employed outside the utility systems, mainly in industrial plants which generate their own power. In all except the largest of these plants, the various operating jobs may be combined. Switchboard operators especially would be found much less frequently in the industrial plants than in utility systems.

Duties

The duties of the various power plant operators are usually distinct. In some small plants, turbine and switchboard operators may be combined into a single job. In others there may be no auxiliary equipment operators as such, this work being divided between the boiler operators and turbine operators. All the power plant operators' jobs are similar in that they are responsible for watching, checking, and controlling the operation of the various kinds of equipment. They must see that the equipment is functioning efficiently and detect instantly any trouble which may arise.

Boiler Operators

The job of the boiler operator, who is sometimes called a fireman, is to regulate the fuel, air, and water supply used in the boilers and to maintain proper steam pressure to turn the turbines. This he does by means of control valves, meters, and other instruments mounted on panel boards. One man may operate one or more boilers. Boilers vary greatly in size and capacity, some producing as much as 500,000 or more pounds of steam an hour at 925 degrees Fahrenheit. In modern power plants the coal is usually fed to the boilers mechanically by coal stokers. In many plants pulverized coal, oil, or gas is piped into the boiler. The boiler operators usually supervise the ash disposal if coal is the fuel. Other workers assist them, such as coal and ash handlers, cleaners, and helpers. Boiler operators of course are employed only in steam generating plants, none being needed in hydro or Diesel plants.

Turbine Operators

Turbine operators, in some plants called running engineers, are responsible for the control and operation of the turbines and generators. In small plants they frequently may also operate auxiliary equipment or a switchboard. Modern steam turbines and generators operate at extremely high speeds, pressures, and temperatures. In a large modern plant, steam enters the turbine at a pressure of up to 1,200 pounds per square inch and at temperatures as high as 900°F. The steam hits the turbine blades at velocities up to 1,200 miles an hour, a force which makes a hurricane tame in comparison. Hence close attention must be given the instruments which show the operations of the turbogenerator unit.

The turbine operator watches pressure gages and thermometers to see that the proper pressures and temperatures are maintained, and records the readings of these instruments. He also checks other instruments which indicate the oil pressure at bearings, the speed of the turbines, and the circulation and amount of cooling water in the condensers which change the steam back into water. The turbine operators are responsible for starting and shutting down the turbines and generators as directed by the switchboard operators in the control room. Other workers, such as helpers, cleaners, and oilers, assist the turbine operator in his duties, and auxiliary equipment operators are sometimes under his supervision.

Auxiliary Equipment Operators

Auxiliary equipment operators regulate and tend such equipment as pumps, fans and blowers, condensers, evaporators, water conditioners, compressors, and coal pulverizers. They check and record readings on the instruments which show how their equipment is functioning. Since auxiliary equipment may go out of order frequently, the operators must be able to detect trouble quickly, make accurate judgments, and sometimes make repairs. The various types of auxiliary equipment are essential to the power plant process, since they are directly connected with the operation of the boilers and the turbines. Coal pulverizers turn coal into coal dust, fans and blowers blow it into the boilers, and compressors mix air into the coal dust to make it burn better. After the steam has completed its journey through the turbines it enters the condensers, where it becomes water. The operation of the condensor in condensing the steam sets up a vacuum which provides some of the force to drive the turbine. Pumps are necessary to return the water to the boiler. As power plants become larger the auxiliary equipment increases in complexity and size, and more of it is necessary to operate the plant.

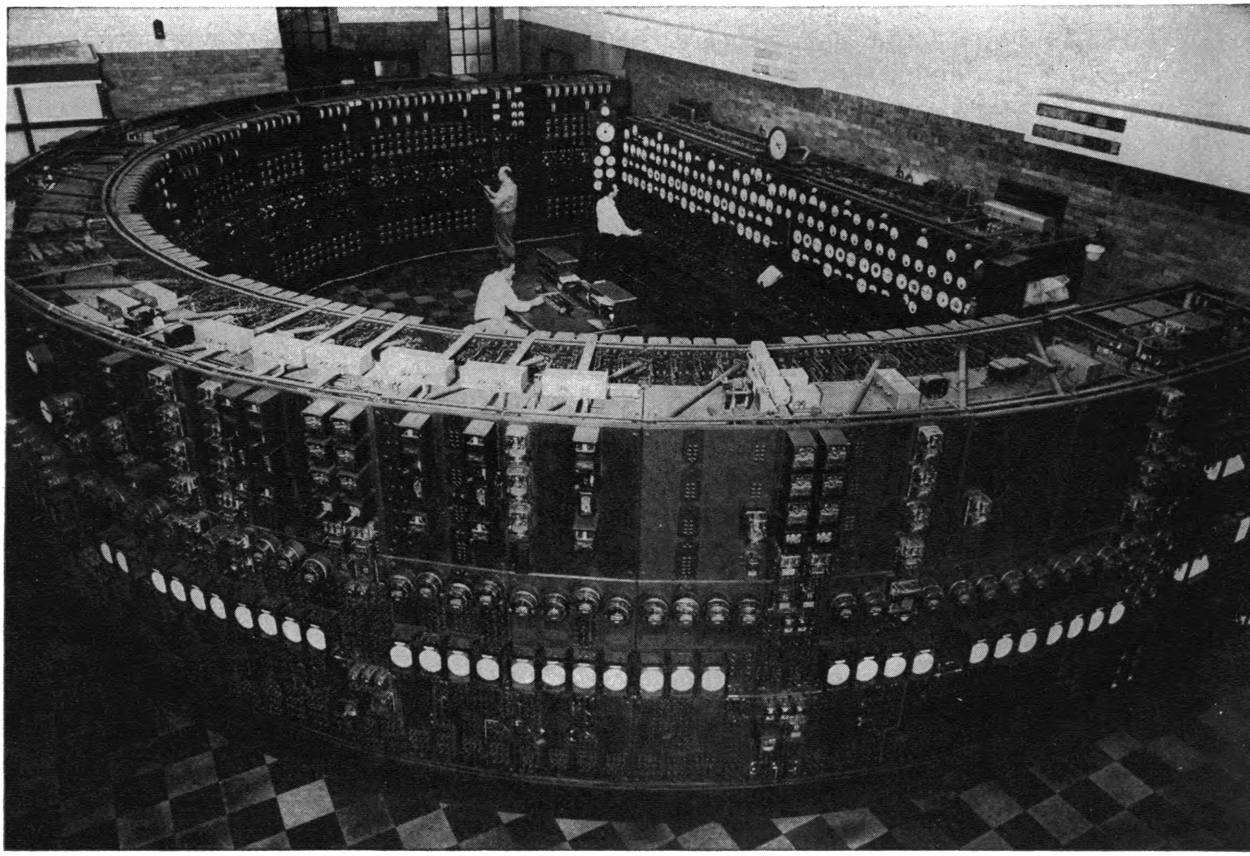
In some of the smaller plants there are no separate auxiliary equipment operators, the turbine operators handling this work along with their other duties. In the larger plants however auxiliary equipment operators often outnumber the turbine operators. The auxiliary equipment operated by these workers is used only in steam generating plants, and no operators are needed by hydro plants.

Switchboard Operators

Switchboard operators control the flow of electric current in the generating station from the generators to the outgoing power lines. They usually work in a control room which is separated from the generating room and which has switchboards and instrument panels. The switches control the movement of the current through the generating station circuits and on to the transmission lines carrying the current away from the station to the users.

The instruments show such things as the total power requirements on the station at any instant, the power load on each line leaving the station, the amount of current being produced by each generator, and the voltage of the current. The operator uses the switches to distribute the power demands among the generators in the station, to combine the generated current in the bus system, and to regulate the passage of the current onto the various power lines in accordance with the demands of the users served by each line. When changing power requirements on the station make it necessary, he orders generators started up or stopped and at the proper time connects them to the power circuits in the station or disconnects them. For most of these operations he receives telephoned orders from the load dispatchers in the system headquarters, who control the flow of current throughout the system.

The switchboard operator also tests frequently, by checking the instruments before him, to see that the current is moving through



General view of the switchboard of a large generating plant showing the switchboard operators checking the instruments mounted on the control panel.

and out of the station as it should and that the proper voltage and frequency are being maintained.

Among his other duties, the switchboard operator keeps a log of all switching operations and of load conditions on the generators, lines, and transformer banks. He obtains this information by making regular meter readings.

In plants with high generating capacity the equipment is generally more varied and complex than in smaller plants. Disturbances in the system may have far reaching effects, causing interruptions in service over a large area. As a result, switchboard operators switch and test more frequently, and a greater degree of skill is required of the operators than in smaller plants.

In hydrogenerating plants the duties of the switchboard operator may be combined with other plant operations—usually generator operating. In such cases, he may be called either a hydrostation operator or a generator-switchboard operator.

Watch Engineers

The principal supervisory workers in a power plant are the watch engineers. They supervise the employees responsible for the operation and maintenance of boilers, turbines, generators, auxiliary equipment, switchboards, transformers, and other machinery and equipment. Directly over the watch engineers may be a plant superintendent, who is in general charge of the entire plant. In small plants the watch engineer may be the top supervisory employee.

Other Workers

Also found in power plants are coal and ash handlers, who may include crane and conveying equipment operators as well as manual workers; oilers, who oil the machinery and equipment; cleaners; helpers; and learners and apprentices. Custodial, clerical, maintenance, and other workers may in some cases be considered a part of a plant's personnel; for example, guards, watchmen, janitors, cashiers and paymasters, and mechanics.

Working Conditions

A generating station is typically well lighted and ventilated and its interior presents a very orderly appearance. Even the steam plants are quite clean, since the coal is handled by mechanical equipment separated from the principal work areas. In the boiler room the workers watch the control instruments mounted on large panel boards. Large pipes feeding pulverized coal to the boilers or carrying steam to the turbines may pass through the boiler room. The boiler room is often rather warm.

The turbine room (where the current is generated) is a long rectangular chamber with rows of turbines in operation, the number and size of the turbogenerator units varying with the size of the power station. The turbine room is airy and clean but there is usually considerable noise from the whirring turbines. The main feature of the power plant's control room is the battery of elaborate switchboards with their numerous switches, clock-like recording instruments, and other controlling and testing apparatus.

Switchboard operators in the control room often sit at the panel boards, whereas boiler and turbine room operators are almost constantly on their feet. Not much strenuous activity is required of the power plant operators and rarely any heavy lifting. Since generating stations usually operate 24 hours a day, power plant employees frequently rotate shifts.

Training, Qualifications, and Advancement

Anyone who wants to get a power plant job will find that most utilities expect new workers to begin at the bottom of the ladder. The methods of training men for power plant jobs vary somewhat among systems, but usually the new employee puts some time in as a laborer or cleaner and then gradually advances to more responsible jobs as he learns more and more about operating the equipment and as openings occur. Formal apprenticeships are rare. How rapidly one advances from job to job depends to a considerable extent on the availability of openings, and if these are infrequent it may take much longer to obtain a particular job than it would take just to learn it.

Typically, after starting as a laborer or helper it takes from 3 to 5 years to become a boiler operator, turbine operator, or switchboard operator. From 1 to 3 years of experience is required to be a fully qualified auxiliary equipment operator. A person learning to be a boiler operator might spend 3 to 6 months as a laborer, then be promoted first to the job of oiler, next to helper or assistant boiler operator, and finally, when there is an opening, to a boiler operating position.

In many plants turbine operators are selected from among the auxiliary equipment operators. The line of advancement in other companies is from laborer to helper to assistant operator to operator. Where a system has a number of generating plants of different size, operators get experience first in the smaller stations and then are promoted to the larger stations to fill vacancies.

Switchboard operators work as helpers, then as junior operators, and finally as senior operators. They also may be advanced from smaller stations to the larger ones, because operating conditions in the larger stations are usually much more complex. Some utilities take men from among the substation operators and transfer them to switchboard operating jobs. The duties of both classes of operators have much in common. In the larger plants switchboard operators can advance to the job of chief switchboard operator.

Watch engineers are selected from the experienced power plant operators. At least 5 to 10 years of experience as a first class operator is usually required to qualify for a watch engineer's job.

Employment Outlook

Increased numbers of power plant workers will be needed to staff the large expected additions to generating capacity. The rise in employment is likely, however, to be considerably less than the growth in plant facilities would indicate. The new plants installed will have many operating features not possessed by many of the older plants, and these will reduce greatly the number of employees per unit of capacity and output. The number of workers in a plant is to a considerable extent related to the number of producing units—boilers and turbogenerators. Usually an operator can handle a large turbogenerator unit as well as he can a smaller one which turns out much less current. Modern large generating plants typically have large units of equipment, much bigger than plants built 20 or 30 years ago, and they have been designed to use as few workers as possible.

Thus, the new generating capacity that will be constructed in the next 10 years will not require a proportionate increase in power plant employment. Frequently when a company installs new generating equipment it replaces some obsolete older equipment. The efficiency of the larger new facilities enables the company to produce much more current with about the same number of generating employees as the old power plant had. This kind of substitution will be common during the coming years and will tend to reduce the number of additional generating plant employees needed. When the new facilities are a net addition to a company's capacity and no existing plants are retired from service, the company will of course have to hire some additional employees to staff the new plant.

Many of the opportunities in power plant jobs will come about because of the death, retirement, or promotion of the experienced workers. A large proportion of electric utility employees have been with their companies for long periods of time, and many are nearing the ages when drop-outs due to death or retirement are more numerous.

Earnings

Of the five principal power plant occupations, watch engineers receive the highest earnings, followed by class A switchboard operators, and the lowest are received by auxiliary equipment operators and class B switchboard operators.

Average straight-time hourly earnings in privately owned utilities in March and April 1948, as shown in table 1, were $1.60 for class A switchboard operators, $1.49 for turbine operators, $1.48 for boiler operators, $1.37 for class B switchboard operators, and $1.35 for auxiliary equipment operators. In all of these occupations the highest average hourly earnings were in the Pacific Coast States, where boiler operators made $1.60; turbine operators, $1.68; and Class A switchboard operators, $1.76. The lowest earnings were in the Southeast region except for turbine operators, whose average earnings were lowest in the Border States, and boiler operators, whose average earnings were lowest in the Middle West. Average hourly earnings for watch engineers were $1.81. Their hourly earnings varied from a low of $1.57 in the Southeast to $1.96 in the Border States and $1.93 in the Great Lakes region.

Transmission and Distribution Jobs

Almost a fourth of the workers employed by electric light and power companies are in transmission and distribution jobs. The transmission system of an electric utility consists chiefly of high voltage transmission lines which are supported by steel towers or poles, except in cities where they are usually in underground cables. The transmission system begins with the step-up substations, which are either in the generating plants or located adjacent to them and which raise the voltage of the generated current to a voltage suitable for transmission. Standard voltages for transmission lines are 33,000; 66,000; 110,000; 132,000; and 220,000. These contrast with the ordinary voltage of 110 or 120 used in homes. The transmission system transports the electricity from the step-up substation of the generating station to the step-down substations, which form the beginning of the distribution system. The distribution system is composed of step-down substations, where the voltage is lowered to 11,500 or less; primary distribution lines, which may be on poles or in underground cables; line transformers, which reduce the voltage so that the current can be used in industrial and commercial establishments and in homes; and secondary distribution lines and service lines which carry the power to the door of the ultimate consumer.

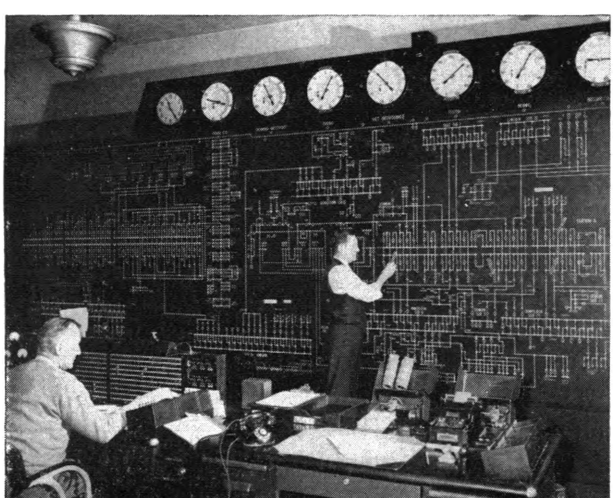
The principal workers of the transmission and distribution systems consist of the men who control the flow of electricity—load dispatchers and substation operators; and the men who construct and maintain power lines—linemen, cable splicers, troublemen, patrolmen, groundmen, truck drivers, helpers, and their foremen. Linemen constitute the largest single occupation in the industry.

Load Dispatchers

Load dispatchers are the key operating workers of the transmission and distribution departments, and in fact of the whole utility system. There were about 1,500 of these workers in early 1948.

Duties. The load dispatcher's room is the nerve center for the entire utility system. From this location the dispatcher controls the plant equipment used to generate electricity and directs its flow throughout the system. He gives telephone orders to the generating station switchboard operators and to the substation operators, directing how the power is to be routed and when additional boilers and generators are to be started or shut down in line with the total needs of the system for power. The load dispatcher must anticipate demands for electric power before they occur so that the system will be prepared to meet them. Power demands on utility systems are not constant: they change from hour to hour. A sudden afternoon rainstorm can cause a million lights to be switched on in a matter of minutes, while boilers often must be heated for as long as 2 hours before they are ready to produce sufficient steam for generating. The load dispatcher must therefore keep in touch with weather reports from hour to hour. He must also be able to direct the handling of any emergency situation such as a transformer or transmission line failure, and to route current around the affected area. Load dispatchers are also in charge of the interconnections with other systems and direct the transfers of current between systems as the need arises.

Pilot board in the load dispatcher's room. Load dispatchers direct the flow of power throughout the utility system.



The load dispatcher's source of information centers in the pilot board, which dominates the dispatcher's room. It is virtually a complete map of the utility system that enables the dispatcher to determine at a glance the conditions that exist at any point. Meters show the output of individual power stations, the total amount of power being produced, and the amount of current flowing through the important transmission lines. Red and green lights may show the positions of switches which control generating equipment and transmission and distribution circuits, as well as high voltage connections with substations and sometimes large customers. The board may also have several recording instruments which make a graphic record of operations for future analysis and study.

Training and Qualifications. Load dispatchers are selected from among the experienced switchboard operators and operators of the larger substations. Usually, at least 7 to 10 years' experience as a senior switchboard or substation operator is required for promotion to load dispatcher. To fill an opening for this job an applicant must show that he has knowledge of the entire utility system, and some companies also have candidates take aptitude tests.

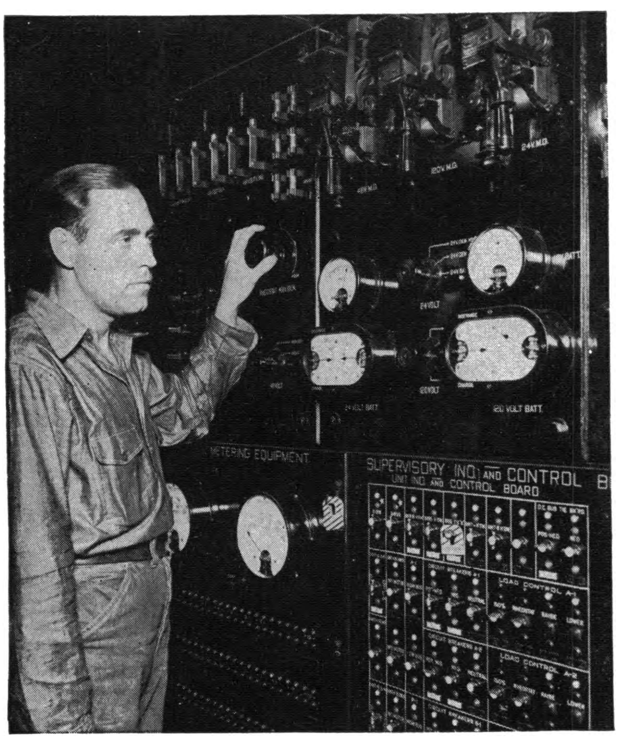
Outlook. The prospective large scale expansion of utility capacity will create a need for some additional load dispatchers. Most openings for load dispatcher jobs will result however from the death, retirement or promotion of those now holding these positions. Only the largest systems employ more than a few load dispatchers. Most systems will not need to increase the number of load dispatcher positions proportionately to handle an increase in generating capacity.

Earnings. Wage rates for load dispatchers are higher than those paid to any other operating or maintenance occupation in the industry. In March and April 1948 the average hourly earnings for load dispatchers in private utilities was $1.94. The highest average hourly pay, $2.16, was in the New England region and in the Pacific region, while the lowest, $1.68, was in the Southwest region. Wage rates for load dispatchers usually depend in part on the complexity of the utility system for which the dispatcher works.

Substation Operators

Substation operators, of whom there were about 8,000 employed in early 1948, rank third in number behind linemen and groundmen among the operating and maintenance workers.

Substation operators check and control the flow of power out of the substations.



Duties. The substation operator is generally in charge of a substation and is responsible for its efficient operation. He supervises the activities of the other substation employees on his shift, and assigns tasks and directs their work. However in small substations he may be the only employee.

A step-up substation is usually located adjacent to the power plant to raise the voltage of the electricity so that it can be sent out over long distances. The step-up substation is chiefly a bank of transformers and oil switches. Step-down substations are at the other end of the transmission lines, in the areas in which the customers are located. There the power is reduced to a lower voltage by another bank of transformers before being sent out through the distribution network. In the distribution substation the current is divided and sent out over the distribution lines to the individual customers. The substation operator directs the flow of current out of the station by means of a switchboard.

The switchboard in the substation is similar in purpose to the switchyard on a railroad. Incoming energy from the power plant is switched to the outgoing lines on which it is needed. The flow of electricity from the incoming lines to the outgoing lines is controlled by the circuit breakers. The substation operator connects or breaks the flow of current by pushing or pulling the switches which control the circuit breakers. Ammeter, volt meters, and other types of instruments located on the switchboard, register the amount of electric power flowing through each line. In some substations where alternating current is changed to direct current to meet the needs of special users the operator controls the synchronous converters which perform the change.

While the substation operator is responsible for properly switching the high and low voltage lines, switching orders are issued to him by the load dispatcher. In addition to his switching duties, the substation operator must check the operation of all equipment and see that it is maintained in good working order.

Training and Qualifications. Substation operators usually begin as assistant or junior operators. It usually takes a total of 3 or 4 years of such on-the-job learning to become an operator in a large substation. Often workers begin in small substations and are promoted to larger stations as they become more experienced.

Outlook. The employment outlook for substation operators is affected by the growing use of unattended stations in areas where consumption of current is light. These substations are being installed by many utility systems in residential and rural neighborhoods. Another development is the underground low voltage distribution network, with transformers placed along the cables at frequent intervals to cut down the voltage before final consumption. Adoption of this method of distributing current eliminates many substations and reduces the needs for substation operators in cities where it is installed. Most utility systems are, however, continuing to use attended substations with operators in areas where electric requirements are heavy and complex. The big expansion of facilities that the Nation's utilities are undertaking will involve the construction and staffing of many new substations. The capacity of existing stations can often be increased considerably however, without a comparable increase in operating personnel. Because of this factor and the trend toward more automatic operations, there will not be a large number of new substation operator jobs. There will be more openings to replace workers who die, retire, or are promoted—probably altogether not more than 200 a year—than openings resulting from system expansion.

Earnings. Hourly wage rates for substation operators in privately owned systems in March and April 1948 averaged $1.53. The average hourly rate varied from a high of $1.69 in the Pacific Coast States to a low of $1.19 in the Southeastern States.

Linemen and Troublemen

Most people have never seen a turbine operator or a substation operator at his job, but the power lineman at work high on a pole is a familiar figure. With the electric utilities serving more than 40 million customers, power lines reach out to almost every factory, store, and dwelling and are being extended to most of the farms. To construct and maintain the millions of miles of power lines more than 23 thousand journeymen linemen and troublemen were employed in April 1948, making this the largest electric utility occupation. Most of them work for privately owned utility companies, but fairly large numbers are employed by municipally owned systems and by rural cooperatives. Federal power agencies and local power districts employed smaller numbers. One of the main sources of jobs for linemen is with construction contractors who install lines for private systems or government agencies.

Duties. The lineman's job is strenuous, involving a great deal of hard climbing on poles and on steel transmission line towers. On new construction, linemen customarily erect the steel towers for transmission lines, while digging holes and raising wooden poles is largely done by the groundmen under the supervision of the linemen. The linemen belt or screw cross arms to the poles or towers and nail or clamp insulators in place on the cross arms. With the assistance of the groundmen they raise the wires and cables and install them on the poles or towers by attaching them to the insulators. In addition, they attach a wide variety of equipment to the poles and towers, such as lightning arrestors, transformers, and switches.

The installation of new lines and equipment is important; however, much of the lineman's work consists of repairs or routine maintenance. When wires or cables break or a pole is blown down, it means a hurry call for a line crew. Linemen splice broken wires and cables, replace broken insulators and bad wires, and replace or repair equipment such as transformers, switches, and lightning arrestors.

Some power companies have several classes of linemen. Those in one crew may work only on new construction. Other crews do repair work on live wires. In some cases linemen specialize on high voltage lines using special "hot line" tools.

Troublemen are journeymen linemen with at least several years of experience who are assigned to special crews which handle emergency calls for service. They move from one special job to another, as ordered by a central service office which receives reports of line trouble. Often the troublemen receive their orders and communicate with the office by radio. Troublemen must have a thorough knowledge of the company's transmission and distribution systems. They first locate and report the source of trouble and then attempt to restore service by making the necessary repairs. A trouble-man may have to restore service in the case of line transformer failure, or he may install new fuses or cut down hanging live wires. He must be familiar with all the circuits and switching points so that he can safely disconnect live circuits in cases of line break-downs. Trouble-men must also know the circuits and locations of switches so that when line troubles occur they can maintain emergency service until repairs can be made.

Training and Qualifications. It usually takes about 4 years of on-the-job training to qualify as a journeyman lineman. In some companies this training is given through a formal apprenticeship, but in most systems there is no definite training program. Under a formal apprenticeship there is a written agreement, usually worked out with the union, which covers the content of the training and the length of time the apprentice works in each stage of his training. A principal feature of the apprenticeship as compared with informal training is that the person entering the apprenticeship is definitely assured of becoming a journeyman lineman if he completes his training satisfactorily and his promotion from one training step to another occurs at specified intervals. Also part of the apprenticeship, when it follows the standards of the Bureau of Apprenticeship, U. S. Department of Labor, is the provision of at least 144 hours of classroom instruction a year. The courses taken include study of electrical codes, blueprint reading, elementary electrical theory, and methods of transmitting electrical currents.

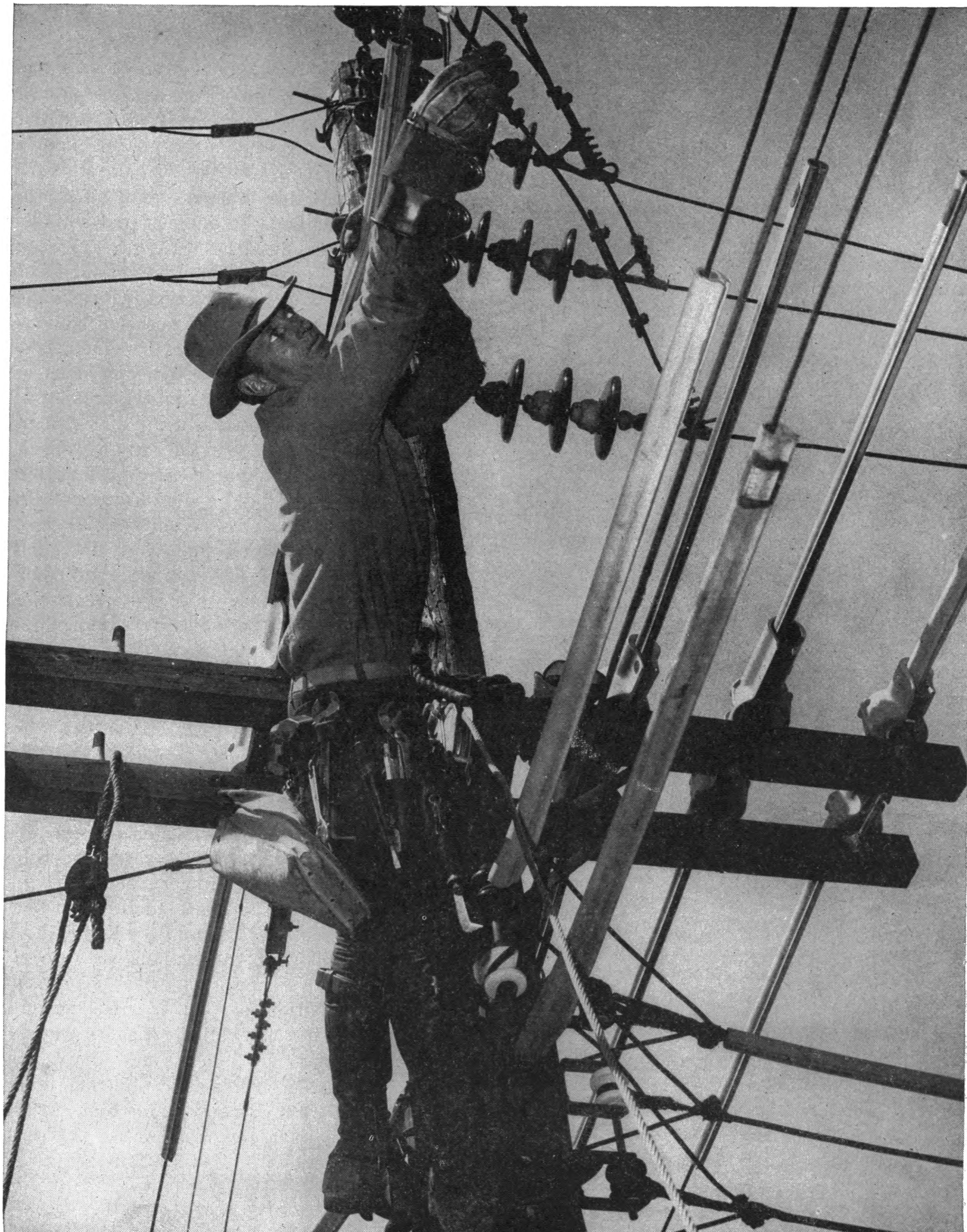
The apprentice usually begins his training as a groundman, assisting the linemen by helping to set poles in place and by passing tools and equipment up to them. After the period of training as a groundman is completed, which usually does not take more than 6 months, the apprentice begins to do simple line work on "dead lines" or lines of low voltage. While on this work he is under the immediate direction of a journeyman lineman or the line foreman. After about a year at this stage he is assigned more difficult work but is still under close supervision. During the last part of his apprenticeship the trainee does about the same kind of work as the journeymen but has more supervision and works on the more routine jobs. During the apprenticeship the new worker learns such things as setting poles in place; attaching cross arms, insulators, circuit breakers, and transformers; and stringing and splicing (joining) the wires or cables.

The training under the informal method is very similar to the apprenticeship and usually takes about the same length of time. The worker also begins as a groundman and progresses through increasingly difficult stages of line work before becoming a journeyman. In both types of training the new workers sometimes start by working on the lines without first getting experience as groundmen.

Some companies have, since the end of the war, set up special training programs for linemen under which the prospective linemen are given a short but intensive training course in actual line practice and in theory. Companies which have conducted these courses have felt they reduce the total training time required by as much as 2 years.

It is obvious that candidates for line work should be strong and be in good physical condition to carry on the strenuous work of climbing poles and lifting lines and equipment. They must also have steady nerves and good balance, to work at the tops of the poles and to avoid the hazards of live wires and falls.

Outlook. During the next 5 years utility systems are expected to hire as many as 2,000 new workers to train for linemen or troublemen jobs. The large expansion in generating capacity will make necessary a considerable volume of work on transmission and distribution lines. For example, hydroelectric plants planned for relatively isolated areas will need transmission lines to connect with the distant distribution areas to which they will supply



The lineman's beltful of tools goes right with him to the top of the pole. Much of the lineman's work is routine repairs or changes in the lines. Storms or accidents may also bring a hurry call for linemen to make emergency repairs.

power. The extension of rural electrification will mean many thousands of miles of new lines in certain farm regions. Lines must be run through the new subdivisions springing up around most large cities. In general when the output of a system is stepped up considerably, even if many new customers are not served, the increased loads on the transmission and distribution systems require substantial alterations in the power lines and other distribution facilities. Not only are linemen needed to work on new lines when they are constructed, but the new lines will add to the volume of maintenance work in future years.

In many of the largest cities a good share of the power lines run underground in cables and are not serviced by linemen. Utility systems can be expected to add gradually to the underground facilities to take care of situations where underground cables would be more practical than overhead wires. Underground installations are very costly, however, and for this reason are not likely to replace overhead lines on any large scale except in the heavily built up sections of cities.

Utility companies have already taken on many trainees for their line crews since the end of the war. Only a part of this increase was to provide for the extension of power lines. Most of the new workers were hired as the companies began to build up their line crews to the prewar size. Training of linemen had been largely suspended during the war.

Over the longer run, after the near future programs for systems expansion have been completed, most of the new openings will be to replace workers who die or who retire from line work. Because of the strenuous nature of line work many of the linemen become unable to continue in the occupation after they pass the ages of 50 or 55. Although some linemen continue at the job in their sixties, most have been transferred to less physically demanding jobs by the time they are that old. Because a good share of the experienced linemen are over 40 years old, within 10 years the drop-outs from the occupations should become fairly numerous. This means that those who get into line work now are assured of steady employment for many years, and that there will be some openings each year for trainees to replace men leaving the occupation.

Earnings and Working Conditions. Linemen and troublemen are among the highest paid of the nonsalaried operating employees of electric companies. The average straight-time hourly earnings in private utilities in March-April 1948 was $1.61 for linemen and $1.63 for troublemen. Earnings of linemen and troublemen were highest in the Pacific Coast States, where both were receiving an average of $1.87 an hour, while the lowest average hourly earnings were $1.49 in the Southwest for troublemen and $1.47 in the Southeast for linemen.

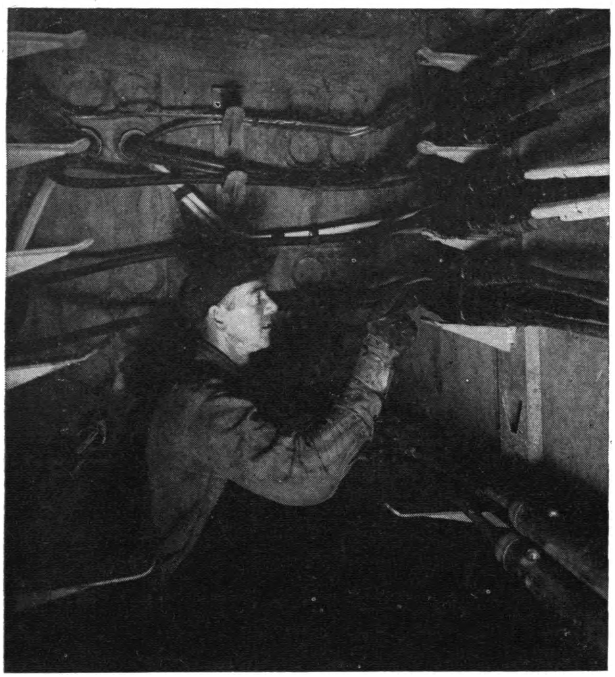
Working conditions are often hazardous or unpleasant because of the extensive amount of climbing involved, outdoor work in all weather, and the danger of electrocution and shock. Working on a "hot" line at the top of an ice-covered pole in a blinding blizzard is not the easiest way to live to a ripe old age. Linemen may occasionally work long and irregular hours during storms, floods, and other emergencies to repair damage and restore service. They may work under a blazing summer sun or in subzero weather. Troublemen regularly work on night shifts as well as day and must be ready to answer emergency calls when off duty.

Cable Splicers

In some of the largest cities a good share of the transmission and distribution systems are carried in underground cables rather than on poles. The extent of underground wiring varies among cities. In some, mainly the high voltage transmission lines and the distribution lines in the downtown sections are underground, but in New York City over 77 percent of the distribution system is underground. Cable splicers are the skilled workers who install and repair the underground lines, performing the same service as the linemen do on the overhead lines. Because cable splicers are needed mainly in a few large cities this is a small occupation, with less than 1,500 employed in April 1948.

Duties. Underground wires are carried in lead-sheathed cables which run in conduits beneath the streets. When cables are installed the cable splicers supervise the laying of the conduit and the pulling of the cable through it. The splicers then join the cables at connecting points in the transmission and distribution systems. At each connection or break in the cable they wrap insulation around the wiring and seal the cable with lead joints much the same as a plumber closes a pipe joint. Most of the actual physical work in the placing of new cables is done by the helpers and laborers who belong to the cable laying crew.

Cable splicers spend most of their time in repairing and maintaining the cables and changing the lay-out of the cable systems.



Cable splicers do most of their work in vaults beneath city streets.

Splicers should know the arrangement of the wiring systems, where the lines are connected, and where they lead to and come from. Each line is numbered throughout its length at every connecting point and switch box and at the control board of the generating plant or substation. The splicer must make sure that the wires do not get mixed up and that the continuity of each line is maintained from the substation to the customer's premises.

It is extremely important that each splice be properly and carefully made. Failure of a poorly spliced cable can lead to serious breakdowns in the transmission or distribution system. The cable splicers usually work in small rooms under the streets, which are reached through manholes. Considerable stooping and working in cramped positions is involved.

Training and Advancement. Cable splicers get their training on the job and it usually takes about 4 years to become fully qualified. Workers usually begin as helpers and then are promoted to be assistant or junior splicers. In these jobs they are gradually assigned more difficult tasks as their knowledge of the work increases.

Outlook. Only a few additional cable splicers will be hired by utility systems in the next 10 years. The use of underground cables for transmission and distribution will be extended gradually to take care of situations where density of power load or difficulties in using overhead wires justify their installation. In view of the high cost of underground construction, no large scale replacement of overhead lines by underground cables is expected. There will be a few openings for new workers to replace those who leave the occupation because of death or retirement, but the opportunities created in this way will not be more than a few dozen a year since the occupation is so small.

Other Transmission and Distribution Jobs

Groundmen

One of the larger occupations in the electric utility field is that of groundman. There were about 12,000 groundmen employed in April 1948 plus several thousand who held jobs as combination truck driver and groundman.

Groundmen are primarily helpers who assist the linemen in constructing, repairing, and maintaining the transmission and distribution lines. They dig pole holes, raise the poles, and at the same time guide them into the holes. After the pole is up, the dirt is tamped around it and guy cables are attached to keep it in place. One of the principal duties of groundmen is to pass tools and equipment from the ground to the linemen working on poles or towers by tying the tools or equipment to a line and hoisting them up.

In addition to their regular duties as groundmen the truck-driver-groundmen drive trucks and operate winches with which the trucks are usually equipped.

Many of the groundmen who show aptitude for line work advance to linemen's jobs, but a large part of them remain among the ground workers.

Patrolmen

Patrolmen, sometimes called line walkers or line inspectors, make up one of the smaller occupations in the power and light industry. In April 1948 there were considerably less than a thousand patrolmen employed by utility systems. These workers are mainly used in rural and isloated areas and usually work very much on their own, with less direct supervision than linemen. They patrol transmission and distribution lines and prepare written reports which show the condition of power lines, substations, transformers, and related equipment. Any encroachment on the right-of-way, such as spreading trees or other conditions which might impair electric service, are also watched for and reported. They check the condition of poles, guys, and anchors and climb the poles or towers to check cross arms, insulators, conductors, and other equipment. Usually patrolmen travel on foot or by automobile, but they may use other means of transportation such as horseback or boat. Even helicopters may be called into service, as they were in a recent experiment in patrolling the transmission lines between Hoover Dam and Los Angeles. Patrolmen are not ordinarily required to make repairs. Patrol jobs are often given to linemen who are no longer able to climb poles.

Utilities that have many power lines passing through wooded areas frequently employ *tree trimmers*. These workers are part of forestry crews whose job it is to cut away tree limbs that are obstructing or touching the power lines or that might fall upon them.

Customer Servicing Jobs

Workers in customer servicing jobs include those who read, install, test, and repair meters

Meters are tested periodically to make sure that they are accurately measuring consumption of electricity.

so that the utility companies can accurately charge each customer for his consumption of current. Also included in this group are men who act as company agents in rural areas and appliance servicemen working in company operated shops which repair electrical equipment owned by the customers.

Duties and Training

Metermen

Metermen are the most skilled workers in this group. About 5,500 were employed by electric utilities in April 1948. They sometimes install meters, and frequently they test them, but their main job is to repair meters, both those on company owned property such as in power plants and substations and those on the customers' premises. Some metermen can handle all types of meters, including the more complicated ones used in the control operations of the utility system and in industrial plants and in other places where large quantities of electric power are used. Others specialize in repairing the simpler kinds, like those used to record consumption in homes. About 4 years of on-the-job training is required to become a fully qualified meterman. New workers usually begin as testers or as helpers.

Meter Readers

Meter readers are the men who go into homes, stores, and factories to read the consumption of current registered on the meter. They record the amount used in a certain period so that each customer can be billed for it. While the job is not physically hard in other respects, the meter reader must walk all day long and there is usually a great deal of stair climbing. Meter readers watch for and report any tampering with the meter or power diversion and other conditions affecting the meters. Over 6,600 men were employed as meter readers in April 1948.

District Representatives

The district representative usually serves as a company agent in outlying districts, in localities where the utility does not have an office and where the small number of customers does not justify the use of more specialized workers. His work includes reading meters, collecting overdue bills, connecting and disconnecting meters, and making minor repairs on them. He also receives complaints about service and reports of line trouble and transmits them to a central office for handling. In April 1948 there were about 3,000 district representatives working for electric utilities.

Other Service Workers

Some companies employ *appliance servicemen,* who install, repair, and service electrical appliances either in a shop belonging to the company or on the customer's premises. In April 1948 the electric utility systems employed over 3,000 of these servicemen. *Meter installers* are specialists who install or remove meters. Similarly, *meter testers* specialize in testing meters.

Employment Outlook

No significant increase in the employment for metermen is expected. The new customers that will be served by utilities and the expansion of generating and substation facilities means that many more meters will be in use. However, the meters installed in recent years are better constructed and require much less maintenance than meters produced 10 or 20 years ago. This improvement in meter performance tends to reduce the needs for metermen.

Meter readers are chosen partly for their ability to get along with people, since they are the company's main contact with its customers.

The number of meter readers employed at any one time depends upon how many meters are in use. Since the millions of new customers that utility systems expect to add will place more meters in service, additional meter readers will be hired. Similarly, expansion of service in rural areas may require more district representatives. However, if the companies open additional offices in some of their outlying territories it will cut down their needs for the district representatives.

Earnings

Class A metermen employed by private utilities in March and April 1948 averaged $1.59 an hour straight time. Appliance servicemen earned $1.45 an hour; district representatives made $1.37; class B metermen, $1.36; and meter readers, $1.18.

In all of these occupations the highest hourly earnings were in the Pacific Coast States. In some areas in the West, district representatives are the most highly paid of the service workers. Generally, the lowest hourly earnings were found in the Southeast, the Border States and the Southwest.

Jobs in the Administrative and Commercial Departments

Various types of clerical workers hold most of the jobs in the administrative and commercial departments. Large numbers of bookkeepers and clerks are needed for accounting work in maintaining a company's financial records and accounts with its customers. Billing machine operators and typists prepare bills sent to the customers, and cashiers receive the payments. Many stenographers, typists, and clerks assist in the various administrative sections. In general, the clerical workers' duties are similar to those of clerical workers in other industries.

Table 1 shows the average earnings for some of the more important clerical jobs in March-April 1948 in private utilities. Men bookkeepers received the highest pay, $1.64 an hour, and men accounting clerks were the second best paid, with an average of $1.36 an hour. In general, clerical workers earned less than most of the operating and maintenance workers.

Even though the complexity of office operations is increasing in many respects, the number of clerical workers employed by electric utilities is not expected to grow at the same rate as total capacity and output. A large part of the clerical work is closely related to the number of customers. While some increase in the number of customers will occur, most of the increased demands for electricity will come from greater consumption by existing customers. However some expansion in the clerical staffs will be necessary, and electric utilities will continue to be one of the main employers of these workers in many communities.

Certain types of professional specialists are needed for administrative and commercial work in the electric companies. Although large numbers are not employed, these jobs are very important. Accountants, lawyers, advertising and public relations experts, and personnel and industrial relations managers are among the key workers in electric utility companies.

Appendix

Capacity, Production, and Employment of Electric Utility Systems, 1902–47

Year	Total utility capacity (as of Dec. 31, in millions of kilowatts)[1]	Total utility production (in billions of kilowatt-hours)[1]	Private utility employment (in thousands)[2]	Year	Total utility capacity (as of Dec. 31, in millions of kilowatts)[1]	Total utility production (in billions of kilowatt-hours)[1]	Private utility employment (in thousands)[2]
1902	1.2	2.5	27	1925	21.5	61.5	193
1903	(3)	(3)	(3)	1926	23.4	69.4	215
1904	(3)	(3)	(3)	1927	25.1	75.4	236
1905	(3)	(3)	(3)	1928	27.8	82.8	(3)
1906	(3)	(3)	(3)	1929	29.8	92.2	274
1907	2.7	5.9	42	1930	32.4	91.1	288
1908	(3)	(3)	(3)	1931	33.7	87.4	265
1909	(3)	(3)	(3)	1932	34.4	79.4	227
1910	(3)	(3)	(3)	1933	34.6	81.7	212
1911	(3)	(3)	(3)	1934	34.1	87.3	219
1912	5.2	11.6	71	1935	34.4	95.3	223
1913	(3)	(3)	(3)	1936	35.1	109.3	238
1914	(3)	(3)	(3)	1937	35.6	118.9	254
1915	(3)	(3)	(3)	1938	37.5	113.8	245
1916	(3)	(3)	(3)	1939	38.9	127.6	244
1917	9.0	25.4	95	1940	39.9	141.8	250
1918	(3)	(3)	(3)	1941	42.4	164.8	255
1919	(3)	(3)	(3)	1942	45.1	186.0	237
1920	12.7	39.4	(3)	1943	48.0	217.8	211
1921	13.5	37.2	(3)	1944	49.2	228.2	203
1922	14.2	43.6	137	1945	50.1	222.5	205
1923	15.6	51.2	151	1946	50.3	223.2	243
1924	17.7	54.7	172	1947	52.2	255.7	262

[1]Includes publicly owned and privately owned utilities. Data for years prior to 1920 are from the U. S. Census of Electric Light and Power Stations. Data for years 1920 to 1947, inclusive, were taken from tables published by the Federal Power Commission.

[2]Includes privately owned utilities only. Sources: U. S. Census of Electric Light and Power Stations for 1902, 1907, 1912, and 1917; Bureau of Labor Statistics for all other years.

[3]Data not available.

Occupational Outlook Publications of the Bureau of Labor Statistics

Studies of employment trends and opportunities in the various occupations and professions are made by the Occupational Outlook Service of the Bureau of Labor Statistics.

Reports are prepared for use in the vocational guidance of veterans, young people in schools, and others considering the choice of an occupation. Schools concerned with vocational training and employers and trade-unions interested in on-the-job training have also found the reports helpful in planning programs in line with prospective employment opportunities.

Two types of reports are issued, in addition to the Occupational Outlook Handbook:

Occupational outlook bulletins describe the long-run outlook for employment in each occupation and give information on earnings, working conditions, and the training required.

Special reports are issued from time to time on such subjects as the general employment outlook, trends in the various States, and occupational mobility.

The reports are issued as bulletins of the Bureau of Labor Statistics, and may be purchased from the Superintendent of Documents, Washington 25, D. C.

Occupational Outlook Handbook

Includes brief reports on each of 288 occupations of interest in vocational guidance, including professions; skilled trades; clerical, sales, and service occupations; and the major types of farming. Each report describes the employment trends and outlook, the training qualifications required, earnings, and working conditions. Introductory sections summarize the major trends in population and employment, and in the broad industrial and occupational groups, as background for an understanding of the individual occupations.

The Handbook is designed for use in counseling, in classes or units on occupations, in the training of counselors, and as a general reference. It is illustrated with 79 photographs and 47 charts.

Occupational Outlook Handbook—Employment Information on Major Occupations for Use in Guidance.
Bulletin 940 (1948). Price $1.75. Illus.

Occupational Outlook Bulletins

Employment Opportunities for Diesel-Engine Mechanics
Bulletin 813 (1945). 5 cents.

Employment Opportunities in Aviation Occupations, Part I—Postwar Employment Outlook
Bulletin 837–1 (1945) (Edition sold out; copies are on file in many libraries)

Employment Opportunities in Aviation Occupations, Part II—Duties, Qualifications, Earnings, and Working Conditions
Bulletin 837–2 (1946). 25 cents. Illus.

Employment Outlook for Automobile Mechanics
Bulletin 842 (1945). 10 cents.

Employment Opportunities for Welders
Bulletin 844 (1945). 10 cents.

Postwar Outlook for Physicians
Bulletin 863 (1946). 10 cents.

Employment Outlook in Foundry Occupations
Bulletin 880 (1946). 15 cents. Illus.

Employment Outlook for Business-Machine Servicemen
Bulletin 892 (1947). 15 cents. Illus.

Employment Outlook in Machine-Shop Occupations
Bulletin 895 (1947). 20 cents. Illus.

Employment Outlook in Printing Occupations
Bulletin 902 (1947). 20 cents. Illus.

Employment Outlook in Hotel Occupations
Bulletin 905 (1947). 10 cents. Illus.

Employment Outlook in the Plastics Products Industry
Bulletin 929 (1948). 15 cents. Illus.

Employment Outlook in Railroad Occupations
In press.

Special Reports

Occupational Data for Counselors. A Handbook of Census Information Selected for Use in Guidance
Bulletin 817 (1945). 15 cents (prepared jointly with the Occupational Information and Guidance Service, U.S. Office of Education).

Factors Affecting Earnings in Chemistry and Chemical Engineering
Bulletin 881 (1946). 10 cents.

Economic Status of Ceramic Engineers, 1939 to 1947
Mimeographed. Free; order directly from Bureau of Labor Statistics.

Occupational Outlook Mailing List

Schools, vocational guidance agencies, and others who wish to receive brief summaries of each new Occupational Outlook report may be placed on a mailing list kept for this purpose. Requests should be addressed to the Bureau of Labor Statistics, U. S. Department of Labor, Washington 25, D. C., specifying the Occupational Outlook Mailing List. Please give your postal zone number.

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