A STUDY OF THE RURAL ELECTRIFICATION IN VIRGINIA AS A BASIS FOR DEVELOPING A PROGRAM FOR THE PROVINCE OF QUEBEC

by

CLEMENT L. MONTGRAIN

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I N T R O D U C T I O N

Electricity, the energy adaptable to so many uses, after having pushed industry into a new era, ought to transform agriculture. It has, in fact, in recent years, invaded this important sphere of activities and given rise to a new science called rural electrification.

In the rural home and on the farm there is a real need for power, light, and heat, as a help in production and in the family welfare. It could even be said that because of the special conditions existing in rural areas, this need is at least equal to, if not greater than that of the cities and factories. This fact and the low cost of electrical energy are the main reasons explaining the rapid spread of the use of electricity on the farm. Electricity has imposed itself by the versatility, simplicity, comfort and cleanliness provided by electrical equipment. It may be expected that tomorrow will yet see a greater use of electricity because of the discovery of new applications, particularly in the field of electronics.

This need of farmers and countrymen for electricity soon created a problem that the Government of various countries understood and solved by passing special laws in favour of rural electrification. The success of such a policy is reflected in the fact that before the present world war, farm electrification had reached 90 percent in Germany, 95 per-

cent in France, and nearly 100 percent in Holland. In 1945, the province of Quebec enacted the first real law on rural electrification; others having been more or less tentatively successful. It is entitled: "An act to promote rural electrification by means of electric cooperatives". This Act mainly concerns the organization of a rural electrification bureau and of cooperatives, and the loans to be made to cooperatives and farmers.

Although this is a great stride toward the solution of the rural electrification problem in Quebec, we can say, from our investigations in the United States as well as in the province of Quebec, that this law in its present terms is insufficient. The rural electrification being the distribution and the application of electricity to rural areas it is certain that the problem is wider than that. It comprises the application of a program in which:

1. The cooperatives, the agricultural colleges, and the companies are equally concerned.

2. Technical principles and data must be applied mainly to decrease the cost of line construction and to increase the consumption of electricity on the farms.

3. The scope should be to make electricity available at low rates to all rural people and to every rural industry as soon as possible.

With these facts in mind, we have undertaken to present this report as we have become acquainted with what is done in the United States, and particularly in Virginia, in the matter of rural electrification. At the same time a special study of the present conditions and of the future possibilities of rural electrification in Quebec was made. The observations gathered in these investigations have logically led us to the object of this thesis, which is to propose a basis for developing a program for the province of Quebec. The conclusions enunciated at the end of this report form the so-called basis of the program.

HISTORY OF RURAL ELECTRIFICATION IN DIFFERENT COUNTRIES

The development of rural electrification has generally been related to the density of population. In regions with a scattered population progress was slow as consumers were not in a position to pay for the costly establishment of rural lines. Moreover, these lines were built at high cost because of the lack of pertinent technical knowledge regarding their construction. After rather recent researches in that field, it has been possible to reduce the cost of rural lines, and consequently to figure the revenue on a lower invested capital with the final result of lower rates. These discoveries, therefore, have compensated for the scarcity of the population along rural lines.

The slowness with which the progress took place is also partially due to the fact that, in the beginning, farmers did not use electricity very much. It is true that rates were rather high, but it is also true that the energy consumption on rural lines was so low that these lines were not self supporting. Farmers were using electricity for lighting only, and yet

.... In the face of these hindrances inherent to the problem itself, many state governments have decided to put on an extensive program of rural electrification.

In Denmark:- In early years, windmills were used for the production of

electric current. Now, farmers are supplied by electric companies. The financing of rural electrification in Denmark was effected on a cooperative basis by means of loans. The success of the enterprise is attributed to the extensive use of motor power and to employment of machinery. There were in 1937, 437 public electric plants. Of those, 347 were entirely rural power stations. It may be stated that at the same date approximately 50 percent of all farm dwellings enjoyed the benefits of electricity.

In France:- Rural electrification in France began in 1919. The power stations then in operation only supplied approximately 7,500 "communes". Rural areas were in exceptional cases supplied by industrial companies as for instance, when there was an industry. General collaboration, both technical and financial between the State, the departments, future consumers and electrical industries, made rural electrification possible. In 1925, a new law promoted rural electrification. The State contributed 3"milliards"* francs in subsidies and 560 millions in loans at a reduced rate of interest. In 1936, 80 percent of the rural population had received electricity. France is the country where electric ploughing is a current practice.

Germany:- In Germany, rural electrification took place with the rehabilitation of agriculture. The power companies have paid special attention to the industrialized agricultural districts. They had to furnish electricity to the milling plants, the factories and brick-kilns,

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* One milliard equals one billion.

dairies and saw-mills, located in the country. To obtain the benefit from the entire utilization of their plants, they developed rural electrification.

The generation of electricity in Germany is usually in the hands of large central organizations controlled by enterprises financed by public funds. In order to increase the consumption the companies fixed new low rates. In special cases, the government gave subsidies to help in the execution of rural electrification programs.

Great Britain:- Before and immediately after the first world war, electricity in Great Britain was confined to large cities and their vicinity. In 1926, a law brought about the establishment of a uniform electrification system for the whole country. The Central Electricity Board was created and took possession of all the primary transmission lines, but not of power stations.

The rural electrification legislation prevailing in Great Britain is very complex. In general, it can be said that it has permitted the amalgamation of different electric power companies and the elimination of those companies which did not show reasonable profit. From this arrangement, English agriculture obtained special benefits. While in 1925, only 200 farmers enjoyed the advantages of electricity, in 1936, the number was 28,000.

Sweden:- The Swedish hydro-electric power and its transmission commenced between 1906 and 1910. There are three different stages in its evolution: (1) State ownership; (2) Private enterprises; (3) Municipally owned stations and distribution; and municipally controlled companies. In the old days, Swedish people used water power by means of various forms of water wheels. During the period 1917-1919, rural electrification began on an extensive scale because of the shortage of petrol.

These plants are under the control of a special State Board called the Royal Board of Waterfalls. Rural Electrification was spread by the rural cooperative associations. These associations are formed of farmers who subscribe the capital required to construct a low-voltage distribution network, and guarantee the interest and sinking fund on loans raised from special State funds or from the banks. The amount to be subscribed depends on the acreage or the number of rooms. The cooperative constructs overhead lines, purchases transformers, and provides connections to each consumer's premises. The Board of Waterfalls helps and advises cooperatives and the public.

Russia:- After the Revolution, electrification became one of the means of transferring the economy of backward Russia to the firm technical base of large-scale socialist production. In 1920, two hundred eminent Soviet scientists and engineers participated in the preparation of a plan known as the Goëlro, - a State Commission for

the electrification of Russia. The plan provided for the construction of a number of large electric power stations with a total capacity of 1,700,000 kwt. within a period of 10 to 15 years. Under this plan rural electrification made great progress. In that country where there is no private ownership of the land, it was easy to choose the best site for building an electric power station and to utilize natural resources to the best possible advantage. Today, the U.S.S.R. is classed among the largest producers of electric power.

United States:- At first the electrical industry paid little or no attention to rural America. The ppincipal reason for this was, according to Mr. H. Slattery, the undeveloped state of electrical science and engineering. In 1910, the National Electric Light Association started an investigation and recommended electrification of rural areas, but the rates were yet too high. In 1921, the N.E.L.A. became the Committee on the Relation of Electricity to Agriculture. The C.R.E.A. was primarily a fact finding organization. It was also an educational agency. Test lines were built under its supervision, like that of Red Wing, for instance. President Franklin D. Roosevelt created in 1935, the Rural Electrification Administration, known as the R.E.A. and the Congress approved on the same year an appropriation of $100,000,000 for rural electrification. This money was available "to initiate, formulate, administer, and supervise a program of approved projects with respect to the generation, transmission, and distribution of electric energy in rural areas".

In the Province of Quebec:- From the beginning up to our days, the rural electrification in Quebec has been accomplished by the power companies. Because of the difficulties pertaining to rural electrification, and as one could easily expect, these companies were much more interested in supplying the big industry. Therefore, in 1930 only 13 percent of the rural population received electricity. While,on the one hand the power companies were protected (as maintained by Mr. A. Rioux) by the provincial government and were astonished at the apathy of farmers towards electricity, on the other hand the government itself was not engrossed in the establishment of a convenient rural electrification system. The movement has been very slow up to 1942. By that time, only 21 percent of the farms were electrified and the war stopped any further progress.

The Rural Electrification Act passed in 1945 gave a new impetus. On date of January 8, 1946, there were 69 cooperatives of electricity already incorporated by virtue of the new law. These cooperatives represented 70,000 patrons and a subscribed capital of over $1,000,000. This is proof that electricity is wanted by Quebec's farmers and that all the efforts must be combined to make Quebec an electrified Province.

INVESTIGATIONS

METHOD AND PROCEDURE

In the general conduct of the work on this problem, efforts were directed along two lines of action as indicated by the original objectives. After a thorough investigation of the rural electrification program in Virginia the compiled information was used in formulating the basis of comparable program for the Province of Quebec. In doing these things the conditions in Quebec were constantly kept in mind in order that suggested recommendations would, in so far as possible, meet the needs.

1. The Study of Virginia's Rural Electrification

The aim of this study was to reach every possible source of information and to secure first hand the latest ideas and practices that have survived and remained in use. As a part of the electrification program in Virginia is closely related to that of the United States, it was possible at the same time to get acquainted with the national organization promoting the rural electrification. Particular attention was paid to the organization of power companies from the administrative as well as the engineering standpoint. This includes, for instance, their internal management, their relations with the farmers, their ways of extending the lines, their rates, their policies and their extension work.

The same line was followed in the case of cooperatives. Here,

however, more stress was laid upon the different steps which have preceded their establishment and their management. In this investigation we could see the relation between the cooperatives and the Rural Electrification Administration. We could at the same time collect much unwritten information regarding the REA itself and, therefore, when later on we will write about cooperatives we will in fact explain the application of the REA's policies.

Another phase of the study has been a brief survey of the uses the farmer makes of electricity according to his type of farming. This statement may also be applied to the special uses of electricity in rural areas, as for example, for irrigation, and for locker refrigeration. These different aspects of rural electrification were easily studied in Virginia where there are power companies, electric cooperatives, and farmers interested in various types of farming. Most of the information has been secured by means of visits to power companies, cooperatives and farms. These were supplemented by attendance at certain meetings and by consultation of literature supplied by the concerned institutions and by library references.

2. Study of the Rural Electrification in the Province of Quebec

To obtain a better understanding of the rural electrification situation in Quebec and in order to compare it with that of Virginia a summer quarter was spent in that Province. Thanks to the authorities of the Department of Agriculture, a collaboration work was done with

the power companies. Under this arrangement it was possible to visit the different agricultural regions of the province and to make a survey of a typical range* in the district of the Quebec Power Co. We could also contact with specialists in rural electrification, and farmers of whom we have asked many questions to learn their opinions on the new applications of electricity in farm processes as the artificial drying of hay. The real merit of this form of study is that it is practical and allows one to secure useful information which one can not get from any literature.

We have been able to realize "de visu" the rôle played by the rural industries in the consumption of electricity in rural areas and their importance in rural electrification.

Mr. A. Riouxm member of the new Rural Electrification Bureau was kind enough to give us an interview in which we discussed the electrification problem in Quebec.

The first cooperative of electricity which is not yet one year old was visited and the manager gave us some useful data about it. From the notes taken all along this investigation, and from the literature obtained, we were in a good position to write adequately about the rural electrification in The Province of Quebec. The comparison of the situation in the two countries will be found in the DISCUSSION

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*Range as meant here is an area or section of the country named after the division of land.

which forms a part of this thesis. The main topics of interest particularly to the Province of Quebec have special mention there.

The logical end of this procedure leads us to the conclusions which are suggestions or recommendations that should be taken into consideration in the establishment of a rural electrification program for the Province of Quebec.

OBSERVATIONS

1. RURAL ELECTRIFICATION IN VIRGINIA

A. Organization of Companies

In Virginia there are two power companies of some importance: the Appalachian Electric Power Company, and the Virginia Electric Power Company. Both companies have been visited and as they have practically the same type of organization no special effort will be made to treat them separately.

The fundamental point of these companies in what concerns rural electrification is that they have a special department for this field of activity. Its rôle consists of taking care of any problem dealing with the distribution and the application of electricity to the rural areas. This department works in close relation with other services and advises them when necessary, always in the matter of rural electrification. All this work is handled by agricultural engineers who form an important unit of this department.

Agricultural Engineers. These men are college graduates in agricultural engineering. They are hired as technical advisers to

the directors of the company or as technicians in the field to help the farmers in engineering problems having some relation with electricity. Because of their special training and their close contact with farmers they also are "key men" for the company when special rural electrification problems arise. So, they play an important part in the extension of new lines, in the securing of right-of-way, in load building work, etc.

Besides those who are in the office, mostly interested in administration work, the agricultural engineers are so distributed in the field that each one will have an average of two counties to take care of. If the territory to which he is assigned, produces a special crop involving special engineering problems, this man becomes a kind of an expert in the subject and is of a great help in solving similar problems happening in other districts. With this arrangement each man supplements the other and the organization is, therefore, very efficient.

Policies in Rural Electrification. Mr. C. P. Spellman of the Virginia Electric Power Company said in an interview the author had with him, that the first step of a company towards rural electrification is to set up a program on the subject. A power company has in fact electricity for sale to the farmers and the rural program explains the conditions of the sale. Such a program should also contain the policies of the enterprise regarding its application. Both companies are proud to exhibit their policies concerning the

extension of the rural lines, their rates, and the services they give to farmers.

Extension of Rural Lines. Inasmuch as the V.E.P. Co. is concerned it is ready to extend its rural lines to supply electricity to any farmer where the density of the population averages three customers per mile. The minimum monthly bill is two dollars for any farmer located at a distance not exceeding one mile from the main line. With this policy the company will build, in the near future, 5200 miles of new rural lines at an average cost of $ 1000 to $ 2000 per mile. (This development plan is contained in the Appendix.) The conditions set forth by the Appalachian Electric Power Co. are a little different. The prospective customers must average four per mile in order to command the extension of a new line. The minimum monthly bill remains the same, i. e. $ 2.00 per month, but that, only to consumers located within one-quarter mile from the main distribution line.

Right of Way. One factor which permits of the extension of rural lines at low cost is the right of way which is given free by the farmer. By special contract the farmer agrees to the installation of an electric line on his property. If any damage is done the company pays for it. The application forms that the farmer is asked to sign bind him and

the company only if the line is built. Both companies have the same policy on this point.

Preliminary survey and canvassing. Before extending a new line a preliminary survey is made to obtain all the necessary information on the present conditions in the area to be electrified. This survey is usually made by automobile and notes are taken along the way. Tenant houses, churches, stores, canneries, mills, and their approximate distance apart and from the road are indicated on a special map.

This first step is followed by a meeting in which a representative of the company explains to the prospective consumers the conditions which are offered to them and which are nothing less than the policies already enunciated above. The attendants at the meeting are also asked at the same time to sign the application form. (See Appendix.) In the days following the meeting an employee calls at each house. When the application has already been signed he simply checks the correctness of the data previously given; he locates the house and the property on the map and asks the wife to sign the right of way if she has not already done so.

Surveying. The company, now provided with all necessary rights, proceeds to put the project into execution. A party of surveyors is sent to the area to determine the location of the line, the placing of the poles, position of the buildings and the topography of the

terrain. All notes like profiles, maps, etc, collected in this field work are brought to the engineering department where the line is designed and a list of material compiled. The construction of the line according to these specifications is either done by the company itself or by contract.

Rates. An important item in a rural electrification program is the rates. There is no doubt that the high rates were, at the beginning, responsible for the low consumption of electricity on farms. The price of this energy, in spite of many factors in its favour, was too high to compete with gasoline power. It was, therefore, one of the policies of the companies to make the electricity available to the rural people at the same price as to urbans. As can be seen in the two forms in the Appendix this aim has been achieved. For a better understanding of rates a resume is made as follows:

The Virginia Electric Power Co. applies its urban residential service rates to rural service. The monthly energy charge is figured on the following basis:

First 50 kwhr. -------- 5¢ per kwhr.
Next 100 kwhr. ----- 3.5¢ per kwhr.
Excess ---------- 1.5¢ per kwhr.
Monthly minimum charge: $ 2.00

With this contract it is permissible to use a motor not exceeding 10 hp.

The Appalachian Electric Power Co. has practically the same rates

schedule. The rural domestic customers engaging principally in agricultural pursuits can benefit from the domestic service rates which are:

First	30 kwhr.	5¢ per kwhr.
Next	40 kwhr.	4¢ per kwhr.
Next	250 kwhr.	2.5¢ per kwhr.
Excess		1.5¢ per kwhr.
Monthly minimum bill:	$ 2.00	

Extension Work. In order that rural electrification be profitable to the farmer as well as to the utility company, it is absolutely necessary that electricity be used to the fullest extent on the farm. Electricity is a burden to the farmer who uses it only for lighting and still pays the minimum monthly charge. He must decrease his cost of production by using electricity as much as possible. This is what the extension work of the company tends to do. It is essentially an educational effort along the following lines of activity:

1. Meetings to interest the rural population in the extension of new lines.

2. Programs with pictures to encourage farmers along existing lines to either install electric service if they do not have it, or to use electricity in a greater amount.

3. Demonstrations to show the use of proved electrical equipment or to promote the utilization of the new applications to the farm.

4. Mailing, writing, broadcasting information of interest to farmers.

5. Home demonstrations by women specialists in equipment.

In the execution of this work the companies are seconded by colleges, county agents, and the distributors of electrical equipment. The agencies distributing electricity have realized, in recent years, the necessity of a properly trained woman to promote the use of electricity in the home. She is usually a graduate in home economics and her work consists in giving home demonstrations on the operation and maintenance of domestic electric appliances. She may also look after home decoration, lighting, kitchen lay-out. Her services have been very much appreciated and this explains her place beside the agricultural engineer in the educational work.

Departmental management. As the management of the rural division of these companies does not differ greatly of that of the general administration, only the items which are unlike will be discussed here. They cover mainly the sale of electrical equipment, the economy of rural lines, and the standards of construction of the same.

Sale of electric farm equipment. Although the power companies do sell domestic electric appliances they are not interested in the business of selling farm equipment. They do not, therefore, have a

special division for that activity. The agricultural engineers, in their work, only suggest the good makes of the equipment needed on the farm leaving to the distributors in the district the job of making the sale. This is in accordance with the policy of the company which is primarily an electricity selling enterprise. With that system there is no duplication of personnel, namely: salesmen and agricultural engineers.

Economy of rural lines. One way of making electricity available to farmers at a low cost is to decrease the cost of construction of lines. This has been possible by the application of new standards of construction which will be explained later. For the moment it can be said that the average cost of rural lines is between $ 1000 and $1200 per mile. These figures have been given by both companies. It is our belief that this cost corresponds fairly well with the facts, although there are several factors affecting the cost.

The Federal Power Commission, under date of May 1, 1935, publishes construction costs from different sources for one mile of rural electric line based on 4 customers per mile. This data for the two electric power companies in Virginia is given in Table 1 which follows:

Table 1. - Construction Costs for One Mile of Rural Electric Line based on 4 customers per mile. (1935)

Construction Items	Appalachian Electric Power Co.	Virginia Electric Power Co.
Primary Voltages used	6900	2300
Primary structures:		
Materials	170.09	165.00
Labor	93.60	95.00
Primary conductors:		
Material	227.58	205.00
Labor	59.04	100.00
Transformers:		
Material	318.10	200.00
Labor	29.21	20.00
Secondary conductors:		
Material	47.90	70.00
Labor	18.25	31.00
House Service:		
Material	21.00	33.00
Labor	8.20	9.00
Meters:		
Material	45.50	30.00
Labor	8.00	5.00
Other costs:		
Right of way and survey	0.00	200.00
Engineering	34.83	80.00
Transportation	61.00	28.00
General overhead	40.98	50.00
Total estimated costs	1183.28	1321.00

The net monthly revenue guarantee per mile based on 4 customers per

mile, was in 1935, $ 20.72 for the Appalachian Electric Power Co. and $ 33.04 for the Virginia Electric Power Co. This is equivalent to a monthly return on capital, of 1.75% and 2.8% respectively. Our calculations cause us to believe that both companies are now figuring on a minimum monthly revenue of 0.67% to 0.75%.

Standards of rural lines. Full details on the construction of rural lines are given in such books as: "Specifications for Rural Electric Distribution Pole Lines" and "Construction Contract for Rural Electrical Distribution Project". It is obvious that it is not the object in this work to go into so many details. Let it be sufficient to write about the main characteristics of rural lines.

The typical rural line is the so called vertical construction "common neutral" type, with the elimination of the crossarm. The phase wire is carried on a pole top pin and insulator and the neutral is clamped on a side bracket. "This type of line is more economical to build and safer to operate than an ungrounded line" (13). This design has also the advantage of being easily convertible from single phase to three-phase by adding a crossarm carrying two more phase wires. Fig. 1 shows this installation.

The rural lines are known for their long spans between poles. By eliminating poles, hardware, and the work of digging a hole, the cost of construction is as much lowered. When the conditions permit it, the

span may be as long as 500 feet. This distance between poles is possible only because special conductors are used. The common practice is to employ an aluminum wire which has been reinforced with steel. This conductor is usually known under the abbreviation: A.C.S.R. According to the specifications of the T.V.A. "three phase circuits and main line single phase routes shall use #4 copper conductors or equivalent (#2 A.C.S.R.) The latter applies particularly to single-phase lines that will likely require future conversion to 3-phase. Single-phase branch primary circuits shall use #6 copper conductors or equivalent (#4 A.C.S.R.)." In Virginia, Southern pine poles treated with creosote are extensively used for single phase primary lines. The poles should have a basic length of 35 feet and fulfill the requirements of the American Society for testing materials and the American Standards Association.

Transformers. Always in an effort to decrease the cost of rural lines the engineers have a long time looked for a low-cost, although efficient, transformer. In the early days of rural electrification they used the so-called rural type transformer which has only one bushing. The cost for this unit was less than the conventional type but at the same time its performance was not very good. After some research in this field, an improved type of single-bushing transformer was put on the market, and is much used today. The usual primary voltage of rural lines is 6900 or 7200 volts.

B. Organization of Cooperatives

With the coming of the Rural Electrification Administration, in 1935, cooperatives of electricity have risen in great number all over the United States. In Virginia, the movement kept pace with that of the whole nation, so that now there are 15 cooperatives distributing electricity, while one in Dayton, Va. is also interested in the generation of electricity. Mr. Chas. E. Seitz, head of the Agricultural Engineering Department, made the necessary arrangements which permitted us to spend some time with the Virginia Electric Cooperative whose headquarters are located in Bowling Green, Virginia.

This cooperative is considered to represent the typical characteristics of such an organization. Judging by the appearance of its building and the organization one can easily come to the conclusion that this is a prosperous enterprise. With the $ 975,000 which it has been allotted, 600 miles of lines have been built. They furnish the electricity to about 3,000 customers. The different aspects of the management and of the internal structure which have been observed in this cooperative can be applied with slight modification to all the others in Virginia and even in the United States. Therefore, an attempt will be made in the next pages to speak in a general way.

Management. The management of the electric cooperatives is so closely associated with that of the Rural Electrification Administra-

tion that one cannot explain the former without speaking of the latter. The Executive Order of 1935, creating the R.E.A., made the money available for rural electrification to "all groups, willing to undertake to supply farmers, whose financial and operating proposals proved satisfactory". The private companies in general did not take advantage of borrowing money at the low rate of interest (3%) to extend new rural lines. The cooperative organizations on the contrary were much more anxious to receive financial help. They took advantage of the offer so much that in 1941, 99 percent of R.E.A. borrowers were cooperatives and public power districts. These last are operated on a system similar to that of the cooperatives. There was for the same time only one private company receiving a loan of $4700 from the R.E.A.

As the cooperatives constitute the main field of activity of the R.E.A. and because of the inability of these organizations to face adequately technical problems involved in the distribution of electricity, different services were provided by the Rural Electrification Administration. This guidance over the individual cooperative is made through the various Divisions namely:

1. Applications and Loans Division
2. Design and Construction Division
3. Finance Division
4. Cooperatives' Operations Division

5. Technical Standards Division

6. Information Division

7. Management Division

8. Personnel Division

This supervision covers a wide range of activities like, "The organization and functioning of cooperatives, system personnel, budgets, office procedure and equipment; materials, right of way and staking line construction, service entrances, power supply; farm and home electrification, line operation, sub-stations, safety activities, industrial power, communications, insurance, and national defense". (19) This enumeration gives an idea of the work performed by this huge organization, it will also help us to better understand its relation with the cooperatives which are the object of this chapter.

The cooperatives of electricity are non-profit organizations incorporated by virtue of one of the different laws permitting their existence in the United States. They are essentially consumer cooperatives in which one member represents only one vote. They are governed by a board of directors, usually elected for one year, whose number varies from 5 to 15.

One of the first duties of this board is to hire a competent manager who must be approved by the R.E.A. before being in office. This man is really the "key" of the whole business, while the board

acts as a supervisor. He looks after every phase of this business: construction, operation and maintenance of the electric lines, internal administration; planning, financing, etc... A staff, composed of at least, a book-keeper, one or two office girls, and a line crew with a head lineman, helps him in his work. The cooperative visited had the following set-up:

1. Office personnel

   General manager
   Secretary
   Office manager
   Cashier
   General clerk
   Stock clerk and work order clerk
   Right of way man

2. Outside personnel

   Foreman
   Assistant foreman (should be 1st class lineman)
   Two second class linemen
   Two third class groundmen

Mr. Brown who is manager of the Virginia Electric Cooperative mentioned that he preferred a central organization because he could follow his men more closely and this permitted him to always send two persons whenever there is trouble on the line. He also said, that as soon as the war is over, he will add the following technicians to his personnel; one electrical engineer, one agricultural engineer, one home equipment demonstrator (girl).

To a question that the author asked about the abilities a manager should have, he answered that the fact of being able to understand the farmers and the rural conditions was the important point. A good background in engineering and economics is a help. In some cases, however, like in small cooperatives, a lineman can do good work. Very often success depends on the quality of the employees and if the manager can create a family spirit among them, his work is much lessened. On that standpoint, it is advisable not to hire any relatives.

Help received from the R.E.A. A cooperative so organized is eligible to receive funds from the R.E.A. for the operation of its business. The money is loaned only after a careful study is made by the central organization. The project which might be the construction of a new line or the extension of an existing line, must pay for itself. When the enterprise is judged feasible by the technicians of the R.E.A. the loan is made and the work is done according to its specifications. The later work of the R.E.A. consists, in certain cases only, in supervising the construction and in giving assistance. The cooperative in itself is a rather weak unit if great activities are to be undertaken. Therefore, the R.E.A. by means of its various Divisions assists it in the educational work, for instance. The section of Education, through its field staff, encourages the rural customers to purchase and use electrical equipment. The "farm equipment tour" which in 1941, traveled over a great part of

the United States is one example of this extension work. Their system of education is not inferior to that of the companies.

The purchasing of material by the cooperative is made by bids to any company which fulfills the specifications and the prices of the R.E.A. This way of buying is called "group purchasing" and permits to a single cooperative the benefit of wholesale prices. The same kind of scheme is used inside the cooperative itself for the wiring and the plumbing of the farm buildings. A group of farmers join together and approach a contractor on the subject. This one makes a job price which is lower than that which each member of the group would pay if the demand was made individually. This system facilitates the loans that the R.E.A. makes to the farmers for these installations.

Policies of the cooperatives. The cooperatives following the instructions of the R.E.A. have adopted the "area coverage" technic, in the extension of their rural lines. "Area coverage merely means making electric service available to all rural establishments in a given area without leaving gaps of unserved sectors within the area or of leaving stranded farms located on the fringes". (25) To determine the boundaries of a region, geographical and physical conditions are taken into consideration. This system requires a special disposition of the rural lines or network as can be seen in Fig. 2.

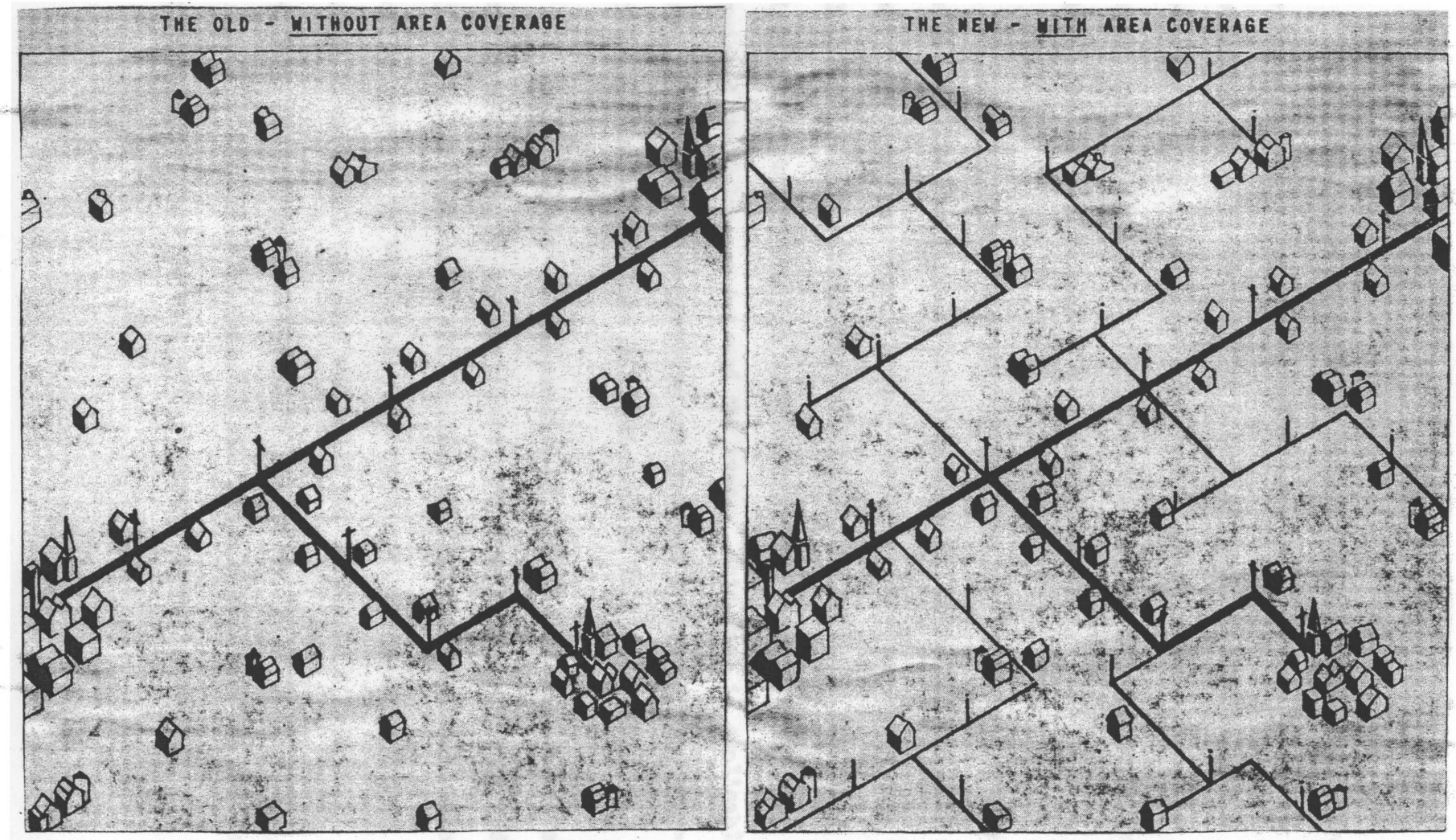

Fig. 2.- Illustration of the "Area Coverage" Technic

Much importance is attached to this technic since the Inter-bureau Committee on Post-war programs says in a report; "In fact, development on an area-wide plan offers the only assurance that virtually all rural homes and other rural establishments, such as schools and churches, can obtain electric service at reasonable rates without the need of subsidies or grants-in-aid".

Right of way. The cooperatives, like the companies, ask the farmers to give the right of way free in order to reduce the cost of construction of their rural lines. Moreover, they sometimes have the help of the farmers themselves for digging the holes or for doing other construction work. In certain cases the members have even furnished the poles, or trimmed the trees. This fact is explicable since members of the cooperative are the real owners of the enterprise and because they have full interest in its prosperity.

Rates. Unless the cooperative of electricity generates its own current it has to buy the electricity from a power company and sell it to its customers. It benefits from wholesale prices which must be approved by the R.E.A. The retail price should be high enough to cover all the cost and allow the saving of a reserve capital; it is usually according to the R.E.A. recommendations. A resumé of the rates in force at the Virginia Electric Cooperative is given here. More details will be found in the Appendix.

Residential farm customers, schools, and churches using a 5 hp motor or having a total meter load not exceeding 7½ hp have to pay;

First	30 kwhr used per month	@	7.0¢ gross, 6.0¢ net kwhr
Next	60 kwhr used per month	@	5.0¢ gross, 4.5¢ net kwhr
Next	60 kwhr used per month	@	3.5¢ gross, 3.0¢ net kwhr
Over	150 kwhr used per month	@	1.5¢ gross, 1.5¢ net kwhr

Minimum monthly bill: $4.00 gross or $3.50 net for each customer requiring a transformer capacity not greater than 5 kva and an addition of .75¢ net per month for each additional kva, or fraction thereof when a larger transformer is required.

A discount is provided for prompt payment. It is the difference between the gross and the net price.

Economy. The economy of the cooperatives is set up to pay interest and repayments on borrowed capital, taxes, insurance, maintenance and repair, and the line depreciation. To that list the cost of energy which has been bought should be added. The rate of interest on loans made by the R.E.A. was 2.46% in 1941, and the period of repayment was 25 years.

The taxes vary with the different States but the R.E.A. has proposed a uniform tax of 3% on gross revenues derived from energy sales. The rural systems are usually insured for $1.50 to $2.00 a mile. Because the insurance rates on lines are too high these are not insured.

At present the maintenance charges average .5%, probably because the systems are rather new. But it is estimated that the maintenance will not go beyond 1%.

The R.E.A.'s procedure of figuring depreciation is one of its own. Each year the cooperative depreciates an amount equal to 3 per cent of the initial value of the system, less the total annual expenses for maintenance and repair. As it is estimated that the systems will still have a value of 75 per cent at the end of 25 years, the depreciation reserve is calculated for only 25 per cent of the initial value for the same period of time.

In table II is shown the operating statement of the cooperative visited. It gives a comparison of the different incomes and expenses for March, 1944, February, 1945, March, 1945. Such a presentation is very useful to the board of directors. A more detailed financial statement for March, 1945, is given in Table III.

Table II. Operating Statement of a Typical Electric Cooperative.

Items	March 1944	February 1945	March 1945
GROSS REVENUE	$15,015.86	$14,805.08	$15,206.16
OPERATING EXPENSES			
Supervision & labor	875.63	1,262.62	1,255.37
Supplies & expenses	352.81	357.74	250.51
Meter Reading-Labor	351.50	561.87	644.39
Meter Reading-Expense	223.00		
Office salary & travel	609.14	724.82	817.45
Office supplies	155.39		
Office expenses	294.73		
Other salaries & expenses	242.13	145.40	150.33
Uncollectible accounts	24.90		
Insurance	70.35	90.30	91.10
Taxes-Property	500.00	717.34	720.61
Taxes-Social Security	56.59		
Maintenance & Depreciation	3,654.44	3,637.45	3,639.39
General expense	67.70	24.34	76.80
Purchased power	4,745.87	3,589.01	3,983.90
Other expenses		68.70	21.00
Distribution expense-Misc.		2.00	
	$12,404.38	$11,281.59	$11,720.86
Interest due & payable	1,916.04	1,322.15	1,325.05
	$14,320.42	$12,603.74	$13,045.90
NET INCOME	695.44	2,201.34	2,160.26

Table III.- A Typical Report to the Board of Directors (March 1945)

Energy sales statistics		
Number billed Consumers	1. Farm	1855
	2. Nonfarm	505
	3. Total farm & nonfarm	2360
	4. Commercial & Other	540
	5. Total consumers	2900
Total kwhr Sold	6. Farm	166,870
	7. Nonfarm	41,091
	8. Total for both	207,961
	9. Commercial & other	103,925
	10. Total kwhr sold	311,886
Average kwhr Used	11. Farm & nonfarm	88.1
	12. Commercial & other	192
	13. Average	107
Number of Minimum Bills	14. Farm	1165
	15. Nonfarm	342
	16. Total for both	1507
	17. Commercial & other	297
	18. Total	1804
Total Billing	19. Farm	$8,003.15
	20. Nonfarm	$2,127.28
	21. Total for both	$10,130.43
	22. Commercial & other	$4,275.72
	23. Total	$14,406.15
Average Bill	24. Farm & Nonfarm	$4.29
	25. Commercial & other	$7.91
	26. Average	$4.97
Wholesale Power	27. Kwhr purchased from 2/28/45 to 3/31/45	418,800
	28. Kwhr sold from 2/20/45 to 3/20/45	311,886
	29. Kwhr unaccounted	98,514
	30. %kwhr unaccounted	24%
	31. Net bill	$3,983.90
	32. Cost per kwhr	.0097
	33. Cost per kwhr sold	.0128
	34. Connected consumers	2890
Revenue	35. Revenue per mile	$14.00
	36. Revenue per member	$4.97

C. Organization of the Agricultural Engineering Department at Virginia Polytechnic Institute

If the two agencies, whose organization and activities have already been described, have done so much to materialize rural electrification in Virginia, it is because the Virginia Polytechnic Institute through its Agricultural Engineering Department, has been the life of the movement. As early as 1924, this department conducted researches in rural electrification; men were trained for service work with the electric companies; extension work in rural electrification was carried on; and consultations were given to farmers and companies. A report of the Virginia Committee on rural electrification (1929) recognizes the usefulness of "an educational agency in the field of rural electrification which can on the one hand instruct and guide the farmer in the use of electricity and at the same time assist the utility companies in understanding and working out the problems of servicing rural consumers of electricity ..... the Agricultural Engineering Department of V.P.I. is regarded as the agency best suited to perform this function."

In 1935, Mr. A. J. Saville, consulting engineer, in a report to the State Corporation Commission on rural electrification (Virginia) "suggests that if any large scale plan is set up that it include some additional facilities at V.P.I. where experimental and promotional work can be carried on that would in our judgment greatly assist in

the promotion of the use of electricity on the farm". It can, therefore, be said that since 1924 this department has suggested directives that different organizations interested in rural electrification have followed. It owes this leadership to its own organization which is built around the three main fields; research, teaching, and extension.

Research. With the help of the United States Department of Agriculture, the Tennessee Valley Authority and the Companies, which furnish either funds or technicians, the Agricultural Engineering Department is always pursuing some experiment to find new applications of electricity to agricultural production. For instance, at the present time, an extensive program on the artificial drying of hay is going on. The preliminary experiments have been instrumental in the finding of an improved design of hay dryer which on the first trial has given very good performance. This discovery has had a repercussion in the field, since there are more than 250 hay dryers already installed in Virginia, and that there is still a great demand for it.

Sometimes research is done to find an improvement in the use of electrical equipment. Various experiments have been undertaken, for instance, in the ways of preparing hot beds for obtaining the lowest consumption of electricity, as well as the best growth of the plants. Following such research, a new steam electric soil sterilizer was developed, a cheap easily built egg cooler was proposed, a milk

utensil ultra-violet rays sterilizer gave good results. These are only a few examples. It would be too long to mention all of them.

Household electrical equipment is also taken into consideration. The performance of electric ranges, washing machines, refrigerators, roasters, is carefully studied. Useful data found on the best and most economical maintenance and operation are published. New ideas are also suggested from time to time on home-made devices.

Teaching. The principal scope of this department, considered as a part of the Virginia Polytechnic Institute, is teaching, and consequently to train engineers fully prepared in the different branches of agricultural engineering. Rural Electrification is one of these branches. In fact the trained man in that field is an agricultural engineer who specialized in rural electrification.

The first year of the course is the same as for all students taking engineering and it is under the supervision of the School of Engineering. The second, third, and fourth years are spent mostly in the Department of Agricultural Engineering, although a few complementary courses are given in other departments. During the last two years the student can elect some subjects of his choice in the field he wants to specialize in, and to which he devotes special attention.

For a better understanding of the program of studies, Table IV

gives the list of courses as distributed in each year.

As can be seen in this table there is, strictly speaking, only one course in rural electrification, but it must be kept in mind too, that the rest of the courses are more or less connected with each other. For instance, the course in rural sanitary equipment, in farm management, in engineering economics, to speak only of these, deal with different aspects of rural electrification. Moreover, the student acquires the fundamentals of electricity in physics, and improves his knowledge on that subject by taking a course in electrical engineering. The whole is completed by working on special problems of rural electrification.

	General Chemistry	3	3	3
	General Chemistry Laboratory	1 1/3	1 1/3	1 1/3
	English Composition	3	3	3
	Introduction to Engineering		1	1
	Engineering Drawing	2 2/3	2 2/3	2 2/3
I	Algebra	3		3
	Trigonometry	3	3	
	Analytical Geometry		3	3
	Physical Education	1	1	1
	Hygiene	1		
	Credits each quarter	16	16	16
	Farm Surveying & Drainage	2		
	Farm Implements			3
	Agricultural Engineering Shop			1
	Station			3
	English & American Literature	3	3	
	Agricultural Geology		3	
II	Mechanism	2	2	
	Manufacturing Methods	2 2/3	1 2/3	2 2/3
	Calculus	3	3	3
	Electives	1	1	1
	Physics	3	3	3
	Physics Laboratory	1 1/3	1 1/3	1 1/3
	Credits each quarter	16	16	16
	Rural Sanitary Equipment		3	
	Farm Motors	3	2	
	Adv. Agricultural Surveying			3
	Soils	3	3	
	Soils Laboratory		2	
	Soil Conserving Crops	3		
	Dynamics			3
III	Mechanics of Materials		3	
	Fluid Mechanics		3	
	Concrete			3
	Principles of Economics			3
	Elec. of Electrical Engineering	4		4
	Engineering Thermodynamics	3		
	Non-technical Electives	3	3	3
	Credits each quarter	16	16	16
	Farm Management	3		
	Agricultural Engineering Seminar	(1)	(1)	(1)
	Farm Structures	3	4	
	Tractors, Trucks, & Autos	2		
	Farm Machinery Design			3
	Soil & Water Conservation	4		
IV	Agricultural Engineering Probls.		2	2
	Rural Electrification		4	
	Soil Management			3
	Business Law			3
	Hydrology			2
	Public Speaking	3		
	Agricultural Journalism		3	
	Technical English			3

The arrangement of this course is, in our opinion, very good and really fulfills the demand. We know by experience that an agricultural engineer having to solve a problem on a farm, must refer to many principles he already learned in class. Because of the diversity of the problems, the training ought to be broad; this is what the present course tends to be. Graduate work leading to a master's degree in agricultural engineering is also offered by this department. This course is of the same standing as that which has just been explained; and what has already been said applies integrally here. However, it must be mentioned that the studies are more advanced and involve experimental research. Now and then, short courses on special subjects are given.

Extension. The agricultural extension division for Virginia has its headquarters at V.P.I. Although the staff of this division works under a single chief it is distributed in the different departments of the School of Agriculture. This organization is very practical since there is excellent cooperation between the fieldmen, the research division, and the teaching personnel. The men in the field can see and are informed of the problems in which the farmers are mostly interested. When they can give the necessary information they do so. On the contrary, they can always ask a professor or a researcher.

These same men can at the same time suggest certain subjects of research whose solution would be of great help to the entire State.

They are in a good position to teach a few courses and advise the teachers on the difficulties encountered and the experience the student must acquire. The same happens with the researcher. This close relation of workers interested in different branches of the same field is the ideal organization for efficient advancement in the diffusion of the science.

The extension man in rural electrification is mostly concerned with the education of rural people. With all the means to his disposal, he holds meetings, gives radio talks, and demonstrations. His work is very similar to that of the agricultural engineer of the companies in matter of education. He covers the country, explaining the principles, the reasons and advantages of a good wiring. Helped by a demonstration panel he explains the different electrical devices, like the fuse, the circuit breaker; he shows the usual type of electric wires and their utility. In another meeting, he will teach the fundamentals of electricity; what is meant by watt, kilowatt, volt, etc...; he will show with charts how the electricity can reduce the cost of production on the farm.

The demonstrations are mostly used for the explanation and the promotion of new equipment, its operation and maintenance. This work is often done in cooperation with the companies' representatives. It is yet in the attributions of the extension agricultural engineer to inform his colleague working for public utilities, of any new development in the application of the electricity to the farm. So, he will

invite them to a short course in which, for instance, all the details of the construction of a hay drier will be given. These men can, after that, help the farmers in their district on such problems. He may give to the distributors of electrical equipment useful information touching the type of motors to recommend for such a job; the installation of special apparatus, etc.... With the researcher he may make some suggestions to the manufacturing enterprises concerning the design of equipment.

D. Virginia Farm Electrification Council

With the increasing needs of rural electrification in Virginia, the necessity was apparent of coordinating all the efforts towards the same objectives. On October 6, 1945, the Virginia Farm Electrification Council was formed to compensate for this necessity since as it is said in the report the purpose of the Council is "to coordinate and expand the farm electrification research and educational activities of the Virginia Polytechnic Institute, the electric service organizations operating in Virginia, and certain other State agencies and organizations interested in the economic use of electricity on the farms and in the homes of rural Virginia".

The membership of the Council is opened to the representatives of the principal agricultural divisions at V.P.I.; to the directors of Vocational Agricultural Education and of Vocational Home Economics Edu-

cation; to each contributing electric enterprise either company or co-operative. These last two organizations provide funds to the Council by contributing an annual amount of 10¢ per rural customer. This money paid to the treasurer of the V.P.I. will partly serve to employ a full-time secretary stationed in the Agricultural Engineering Department at V.P.I.

One would have an idea of the extensiveness of the activities of this Council by considering that all means of publicity would be used. It will for instance prepare in cooperation with V.P.I. departments and other agencies, educational material to be used by 4-H clubs, FFA chapters, home demonstration clubs, agricultural and home economics classes in high schools, farm organizations and other interested groups. "The Council will also sponsor short courses for wiring contractors, service men, and others who do the important job of installing and servicing electrical equipment on farms."

It is yet too soon to judge the results of this agency but it can be said that with such a good set-up and centralization only the best success should be expected. The future will prove it.

E. Rural Industries

It is a well known fact that the rural industries played an important rôle in the extension of new rural lines right at the beginning of rural electrification. Very often, farms which normally

could not afford electricity under prevailing conditions were able to take benefit of it, thanks to rural industry. The power company in serving this cannery or this locker plant, could connect the customers along this line at special rates. Nowadays the picture is a little changed, since the aims are to extend, at a reasonable price, electric service to every rural people. The rural industries are now considered as a good source of revenue which would compensate for the low income received from rural customers. With rural factories, therefore, the rural electrification is more profitable as a whole and is more attractive to the distributing enterprises; any rural electrification program should take this factor into consideration. Although it would be interesting to speak of all the different rural industries one example will be sufficient to illustrate our thought.

Locker Refrigeration. This rather new industry has spread out rapidly. In 1944, there were more than 4000 locker plants in the United States. In Virginia in the last three years, 18 new plants have been opened, showing that the movement is well launched, and that rural people are much interested in this way of preserving their perishable products. The system essentially consists of a central building having a room kept at a low temperature (0° F) and in which are individual lockers. These lockers are rented at $10.00 a year to the patrons who can keep from 200 to 350 pounds of meat or other food at one time. Usually other facilities are provided, such as the processing of meat.

This way of preserving food is very cheap and there is a real economy in renting a locker. Good sources of information give estimates of savings. These compare the farm value of the 800 to 1000 pounds of meat, supposedly consumed on the average farm in a year, plus the locker and plant service charges, with the cost of the same meat at local retailed prices. They give a saving of 9.5¢ to 10¢ per pound, and a total annual saving of $75.00 to $100.00. A saving of .07¢ per pound on meat can, therefore, be assumed as a general rule.

While serving the rural people the locker plants are a good source of income for the power utility. The general practice is to calculate the cost of power and light in a 300-locker plant as being $2.00 per year per locker. An analysis of operating costs made by S. T. Wabbington in 19 locker plants in Illinois, (1941) shows a minimum cost for light and power of $1.34 and a maximum of $5.36 with an average of $2.75 per locker per year. Considering a 300-locker plant and a revenue of $2.00 per locker this means an annual return of $600.00 a year for the power company; this amount is equivalent to 25 individual customers paying only the minimum monthly bill of $2.00.

There are, without doubt, other rural factories which considered as a unit bring more money than a single locker plant but we believe that as a whole, because there may be many in a same district this is an industry that should be taken into consideration. This matter has

been brought up instead of others because of its possible future application in Quebec.

F. Use of Electricity in the Home and on the Farm

One phase of rural electrification, as has already been said, is the application of electricity to rural areas. This statement involves a particular reference to the use of electricity in agricultural production. A farm can, indeed, be compared to a big manufactury where time and labor are main factors in the determination of profits. Human work is very expensive and this explains why tractors and modern machinery are so popular in our fields. They allow the farmers to do more work with less effort in less time. The same thing could be said of the electric equipment which for five cents can effect the same amount of work that a man can do in an 8-hour day. At the present low cost of electricity, while the wages are in general so high, there is a real opportunity for the farmer to use more electricity on his farm. Let us see how electricity can help a farmer in his enterprise.

The first convenience on a farm, considered as a center of production, is running water. Fresh water always within the cows' reach is an insurance for higher milk yield. After researches made at Minnesota University, the presence of a water system on a farm can increase the milk production from 5 to 10 per cent. When it is known that the electric motor is the most economical way of running a pump

it can be said that electricity is the first servant on the farm.

The milking machine is of daily use. It is recommended on any farm of ten cows or more. The U. S. D. A. has made an investigation on the utility of this apparatus. The conclusion was: a saving of 684 hours of work a year. The Westinghouse Company contends that with a herd of 15 cows, 50 days of work are saved each year.

It is not all to increase the yields, it is also necessary to furnish a product of high quality. The milk cooler is equipment which helps the farmer in that way, besides preventing certain losses during very hot spells. Figures furnished by the U.S. D. A. show that it is $4.00 to $5.00 cheaper to cool the milk with electricity than with ice.

A new application of electricity to farming has appeared these last years; the artificial drying of hay. This method which is very popular in Virginia permits, according to experiments done at V. P. I., an increase in the value of the hay of $5.00 to $10.00 a ton, in retaining its nutritive elements. This method could, in all probabilities, have an application in the province of Quebec.

In the near future, an automatic electric barn cleaner will be seen in operation. It will relieve the farmer of the long back breaking job of cleaning the barn. Some preliminary calculations cause us to say that this device will reduce the farmer's work by 400 to 500 hours a year.

The electric brooder requires less attention and care than the other types. Moreover, it has been proved after experiment, that chicken, kept under this brooder have better health because of the constant uniformity of heat.

The artificial lighting of the poultry house increases the egg production. Increases of as much as 20% in winter time have been reported when artificial lighting and water heating have been used.

In the piggery a very simple device, made of an electric lamp with a reflector can save many young pigs. A report from Purdue University mentions that one or two young pigs are saved per litter. The same rudimentary device can be used for sheep.

Very often, under our climate one must help nature to activate the growth or obtain a better vegetation. Electricity is a dependable help in furnishing the electric hotbed and permitting irrigation. In the spring a hotbed heated with a cable or electric lamps may be a very helpful device to the farmer. It does not require any special preparation, and the uniform temperature that it is possible to maintain has very good effect on the plants.

No one ignores the rôle of water in the life of plants. If adequate water is lacking, the growth is severly threatened and the yields are smaller. The Clemson Agricultural College has proved that a weekly watering of one inch could double the production.

Electricity finds increased use in fruit production. One of its important uses in this line would be for operating stationary spray plants. This type of spraying system is vaunted for its qualities. The spraying time and work is cut by one-half to two-thirds; inter-crops, permanent cover crops, branches and fruits are not injured, as no tractors or teams are used. The condition of the soil is no longer a hindrance in spraying at the right time. An electric motor can furnish the power to a spray pump at a very low cost. A system requiring a 5 H. P. motor would, for instance, consume about 6.5 kwhr per acre sprayed. There are many other uses of electricity on the farm. A description of all of them is impossible here. To simplify the presentation and the understanding, the principal uses of electricity, with their average monthly kilowatt hour consumption are given in Tables V and VI.

Table V.-- Different uses of electricity in the farm home.*

Usage	Consumption			
Clock	2	kwh.	per	month
Coffee percolater	5	kwh.	per	month
Curling iron	½	kwh.	per	month
Dish washer	2½	kwh.	per	month
Fan (household)	2	kwh.	per	month
Fan (kitchen)	8	kwh.	per	month
Heater (glowing or radiant)	1	kwh.	per	hour
Heating pad	½	kwh.	per	hour
Heating (oil burner)	25	kwh.	per	month
Household motor	1	kwh.	per	month
Iron (hand)	5	kwh.	per	month
Ironer	10	kwh.	per	month
Lighting	20	kwh.	per	month
Radio	8	kwh.	per	month
Range	120	kwh.	per	month
Refrigerator	35	kwh.	per	month
Sewing Machine	½	kwh.	per	month
Toaster	3	kwh.	per	month
Vacuum cleaner	2	kwh.	per	month
Waffle iron	2	kwh.	per	month
Washer	3	kwh.	per	month
Water heater	240	kwh.	per	month
Water pump (shallow well)	8	kwh.	per	month
Water pump (deep well)	10	kwh.	per	month

* Data given by the R. E. A.

Table VI.-- Different uses of electricity on the farm.*

Usage	Consumption
Cider mill (small jobs)	1 kwhr per 100 gal.
Barn ventilator	2.5 " per cow per month
Bottle washer	1/2 kwhr per 1000 bottles
Brooder	1/2 kwhr per Chick
Churn	1 1/2 " per 100 # butter
Clipper	.1 " per hour
Concrete mixer	1/3 kwhr per cu. yd.
Corn husker - shredder	30 kwhr per 100 bu.
Corn sheller	1 kwhr per 30 bu.
Cream separator	1/2 kwhr per 1000 # milk
Dairy refrigerator	30 kwhr per 10 gal. milk (daily per month)
Dairy water heater	1 kwhr per 5 gal. (145° F.)
Ensilage cutter	1 kwhr per ton
Electric fence	7 kwhr per month
Fly screen or trap	5 kwhr per month
Grain elevator	4 kwhr per 1000 bu.
Grain grinder	1/2 kwhr per 100 #
Seed cleaner	1 kwhr per 100 bu.
Feed cutter and shredder	2 kwhr per ton
Hay baler	2 1/2 " per ton
Hay drier	40 kwhr per ton of dry hay
Hay hoist	1/3 kwhr per ton
Hotbed	1 kwhr per sq. ft. per day
Incubator	1 kwhr per 25 eggs set
Irrigation (surface)	3 kwhr to raise an acre-foot of water one foot
Milking machine (portable)	1 1/2 kwhr per cow per month
Milking machine (pipe line)	2 1/2 kwhr per cow per month
Paint spray	1 1/2 kwhr per 1000 sq. ft.
Poultry house lighting	5 kwhr per 100 birds (month)
Poultry water heater	1 kwhr per day
Sheep shearer	2 kwhr per 100 sheep
Straw cutter	2 kwhr per ton
Threshing machine	1 kwhr per 8 bu.
Tool grinder	1/2 kwhr per hour
Ultraviolet lights for poultry	10 kwhr per 100 hens (month)
Utility motor (1/2 H.P.)	1/2 kwhr per hour
Utility motor (3 & 5 H.P.)	1 kwhr per horsepower per hour
Water pump (Shallow well)	15 kwhr per month
Water pump (Deep well)	20 kwhr per month
Wood saw	2 kwhr per cord

* Data given by the R. E. A.

2. RURAL ELECTRIFICATION IN QUEBEC

The same causes which have delayed the expansion of rural electrification in the United States have also existed in the province of Quebec. They explain the reason why actually only 20 per cent of the farms in this Province receive electricity although it is the largest producer of electricity in Canada, as is shown in Table VII.

Table VII — Used and Potential Hydraulic Power in Canada.

Province	Potential power in 24 hrs. 80% cap. Normal flow in six months- H.P.	Turbines Installed Dec.31,1942 H.P.	Turbines Installed Dec.31,1943 H.P.
Prince Edward Island	5,300	2,617	2,617
Nova Scotia	128,300	143,717	135,384
New Brunswick	169,100	133,347	133,347
Quebec	13,064,000	4,839,543	5,847,322
Ontario	6,940,000	2,684,395	2,673,443
Manitoba	5,344,500	420,925	422,825
Saskatchewan	1,082,000	90,835	90,835
Alberta	1,049,500	94,997	94,997
British Columbia	10,998,000	792,563	796,024
Yukon and North West	731,000	22,899	19,719
Canada	39,511,700	9,225,838	10,214,513

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While other provinces, like Ontario for instance, were well organized to face that problem, and could buy electricity from Quebec, the latter was satisfied to be in (1941), the fourth rank for rural electrification. Table VIII shows the relative positions of the Canadian provinces in matter of rural electrification.

Table VIII.-- Rural Electrification in Canada.

Province	Percent of electrified farms
Prince Edward Island	5.4
Nova Scotia	26.0
New Brunswick	18.5
Quebec	19.6
Ontario	37.0
Manitoba	7.3
Saskatchewan	4.7
Alberta	5.4
British Columbia	35.8
Canada	19.8

This situation was due to the fact that the Quebec provincial government, up to recent years, without helping private companies or farmers, did not even take into consideration certain reports presented by committees appointed to study rural electrification. On another hand, it was protecting the big industries which were exporting electricity. Happily the conditions have changed and it seems that now the rural electrification movement is well started.

Of the electricity generated in Quebec, in 1942, 11,271,965 kwhr were used on 28,419 farms. This energy represented a value of $607,184. If an analysis of these figures is made, it is found that the average annual consumption on the electrified farms of this Province, is 396 kwhr and that the corresponding bill is $21.36. In the same period of time 66,076 Ontarian farmers were using individually a little more than 1,800 kwhr a year, and were paying to the "Hydro" $44.43. A further study shows that in Quebec the cost of one kilowatt of electricity amounts to 5.4 cents compared to 2.46 cents in Ontario. It must not be concluded, however, from that comparison that electricity is more expensive in Quebec than in Ontario. On the contrary this is a proof that Quebec's farmers do not use enough electricity to take benefit of the lowest rates offered, and to insure, in general, an interesting return to the distributing enterprises. This is probably at the present time the most important cause acting against rural electrification, as we have been convinced by our visits all over the Province.

A. Division of the Province on the standpoint of rural electrification

The Province of Quebec can be divided into six regions as regards rural electrification. They are:

1. Region of Gaspé Peninsula
2. Region served by the Quebec Power Company
3. Region of Lac Saint-Jean
4. Region served by the Shawinigan Water and Power Company, and the Southern Canada Power Company
5. Region of the North of Montreal
6. Region of Abitibi and Temiscamingue

This classification corresponds very well to the agricultural geography of the Province and to the present distribution of the electric power companies. Each region, indeed, presents certain agricultural and industrial conditions which are particular to itself and it seems that the power companies at present serving some of these regions, have fixed the limits of their district to fit into the boundaries of a region. The map shown on next page illustrates the location of these regions and their approximate limits. A brief study of each region will help us to better understand the rural electrification problem in the Province of Quebec.

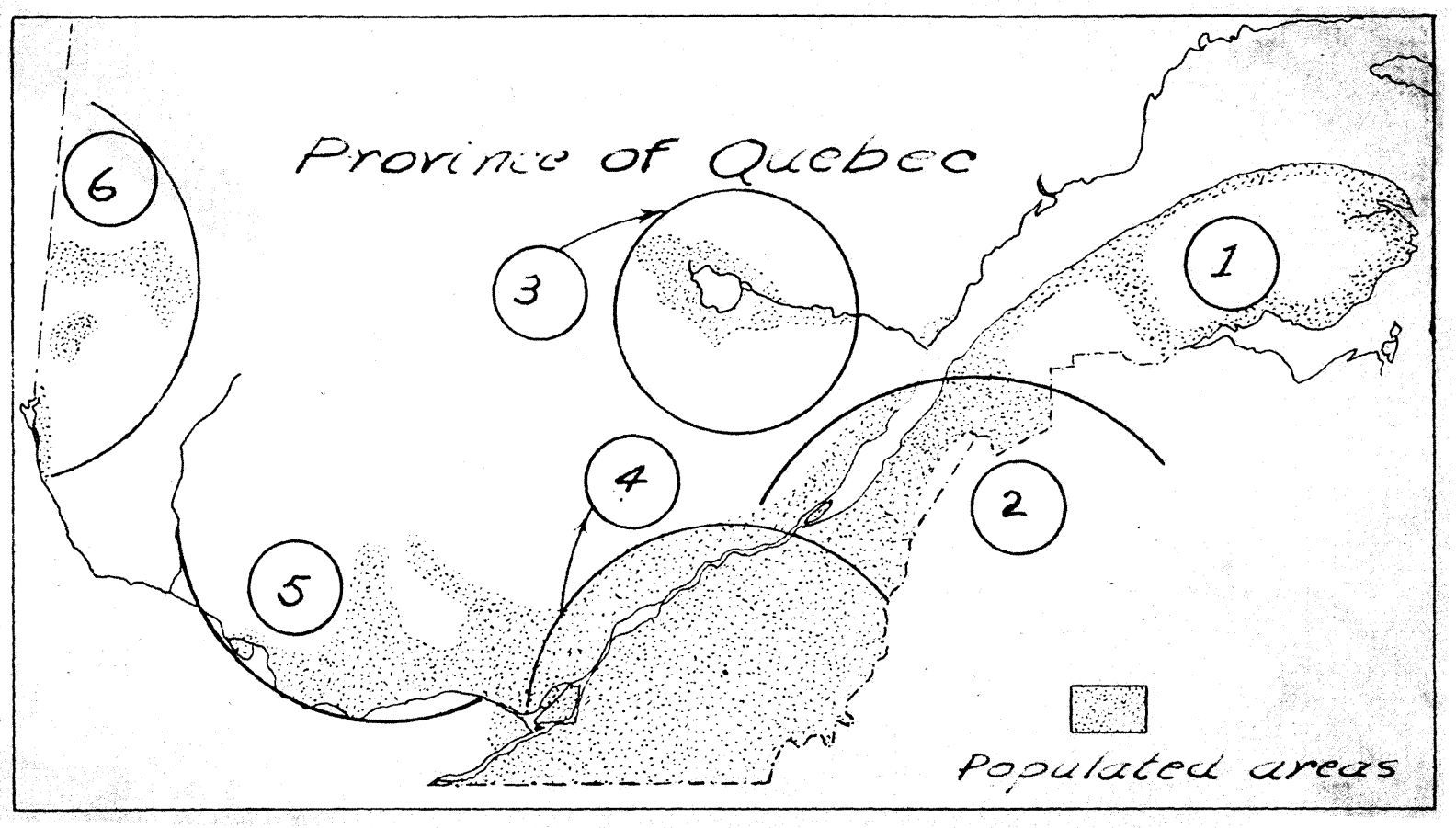

Fig. 3.- Division of the Province of Quebec on the Standpoint of Rural Electrification

The Region of Gaspé Peninsula. This territory is mountainous and besides few inland settlements the parishes are all located along the north and south coasts. In general the agricultural possibilities are small and the farmers usually receive a supplementary income from the forest or the fishery. The sectors neighbouring the towns are fairly well electrified but in remote parishes electricity is still to come. The difficulty seems to be the low density of the population and the scattering of the parishes. It is our belief, however, that rural electrification could be established, rather easily and on a profitable basis, with a good program embracing the whole region.

The region served by the Quebec Power Company. This district is divided in two by the Saint Lawrence River. While the north shore part of it is rather poor for agriculture, the south shore is, one can say, prosperous. Although colonization is still going on in certain parishes there is in general a great number of good farms and well developed rural industries. Rural electrification has reached a high level in this region which is, as a whole, the most electrified.

Region of Lac Saint-Jean. First opened in 1938, for the exploitation of the forest this center soon attracted people because of the quality of its soil. It ought to become, nowadays, an agricultural, a forestal and an industrial region. The agriculture is normally developed and there is a good market for farm products. In this "Kingdom of Electricity" one would wish that rural electrification be well progressed, but there is still much to do in that field. Ranges, with a high density of population,

are not yet electrified. The service entrance installations are rudimentary although the distribution system is generally of the "common neutral" type. No doubt, that with the application of a program of rural electrification great progress would take place in the extension of new rural lines and consequently in the agriculture and in local industries.

Region served by the Shawinigan Water and Power Company and the Southern Canada Power Company. This region, comprising practically half of the counties of the Province, represents an important item in the rural electrification of Quebec. It covers an area of about 12,000 square miles and contains the most prosperous parishes of the Province, of which many are located in the vicinity of the greatest market of Canada, Montreal. In the whole, it can be said that rural electrification in the territory served by the Shawinigan Company is well started. Mr. H. Massue's report mentions that 33,6 per cent of farms were electrified in date of December 31, 1942, and that another 7.6 per cent of farmers could receive electricity immediately if they wanted to be connected to the existing lines. On the contrary, the Southern Company does not seem to have worried about electrifying rural areas. Many fine and well populated ranges are still waiting for electricity.

Region of the North of Montreal. One could fix the limits of this region by saying that it contains all the parishes scattered in the Laurentian Mountains between the Ottawa River and the farthest establishments called Sainte-Anne du lac. Actually the Gatineau Power Company and

some other local enterprises distribute the electricity. In general the density of the population is low and the agriculture is mediocre. The forest constitutes an industry equal if not superior to agriculture and brings, a good amount of money to residents, as a supplementary source of income. The rural electrification, as one could expect is not very much spread, but the existing obstacles do not pose an insolvable problem. They could easily be overcome and it is our belief that the application of the "area coverage" principle would be of a great help.

Region of Abitibi and Temiscamingue. This "New Country" where the mining industry, the exploitation of forest, and the agriculture are the principal activities, does not have any rural electrification. The lines supplying electricity to towns scarcely extend to the two or three first houses of adjacent ranges. However, there are, everywhere in this region, ranges with a dense population which could certainly bring good dividend to an enterprise. There is a real need for electricity in this locality; proof, the farmers are now organizing many cooperatives of electricity. Because of the present conditions it is the most propicious place in the Province to apply a broad program of rural electrification. A typical electric rural system could, therefore, be established. It is even possible that a project similar to that of the Tennessee Valley Authority could find an application there. The drainage of the land and the transportation of the pulp wood could, one of these days, require the presence of such a system. It would be wise to begin with the education of farmers and, as they have not yet bought much mechinery, it should be easy to recommend to them the use of electrical equipment each opportune time.

B. Organization of Companies

The discussion here, will bear on two companies which have received a particular attention in our study of the rural electrification in Quebec; the Shawinigan Water and Power Company and the Quebec Power Company. Even though the latter is a subsidiary of the holding company Shawinigan, its administration is entirely different, and it is better to treat of this company in a special heading. They represent exclusively the biggest distributor of electricity in Quebec, since more than two thirds of the population is supplied by these two companies.

The Quebec Power Company. On the standpoint of rural electrification this company is certainly the best organized in Quebec. Five years ago, a special department was created to manage this phase of activities, and an "agronome" was hired to take charge of it. Since then, a new "agronome" and three fieldmen have been added to the staff. According to the chief of this department, it is his intention to hire, in the near future, an agricultural engineer and a graduate in Home Economics to complete the staff. As can be seen, the prospective set-up compares favorably to that of the American power companies and should give the same good results already noticed in the United States. The Company does not want to remain stationary in matter of rural electrification. It has adopted special policies regarding rural lines.

Policies. The extension of the rural lines is made in about the same way as that of the utilities in Virginia. Preliminary surveys, meetings, canvassing, all these different steps are undertaken when a rural line is projected. It is also the common practice for the farmers to give the

right of way. At present the rural lines in this district are built where the density of customers averages 6 per mile.

Rates. The Company has two types of rural rates; one for the farms where the total load is not higher than 5 hp and the biggest motor is 3 hp, and the other for the farms exceeding these limitations.

In the first case the rates are so distributed:

Monthly fixed charge	22¢
First 40 kwhr	5¢ per kwhr
Next 160 kwhr	2¢ per kwhr
Balance	.9¢ per kwhr

Minimum monthly bill@ $1.00
Discount of 10% for payment within 15 days

Heavy duty farm rates

Availability; all farms where the connected load in the non-residential section exceeds 4 kw or 5 hp and where motors larger than 3 hp are used.

Service charge:	33¢ per month
First 13 kwhr per kva of demand	5¢ per kwhr
Next 53 kwhr per kva of demand	2¢ per kwhr
All additional consumption for	.9¢ per kwhr

Minimum demand 3 kva
Minimum monthly payment: $2.00
Discount of 10% for payment within 10 days

A close examination of these rates shows that they are lower than those generally in force in Virginia which gives an advantage for rural electrification in this section of the Province.

Extension Work. The Company has not gone, as yet, very deeply into the extension business. However, a few pamphlets on wiring have been published; demonstrations have been a current practive for some years, and each summer the rural electrification division has an exhibit in the different fairs held in the district. There are not, in so far as we know, special training schools and real extension programs, in the manner seen in the United States. It is, nevertheless, the intention of the Company to organize such educational work at the earliest convenience.

It should be mentioned here that the Quebec Power Co. is perfectly aware of the rôle that an agricultural engineer could play in this extension work. It recognizes the necessity of such a man to handle the agricultural engineering problems which arise in the application of electricity to the farm and to rural industries. It is understood that the same trained person could conduct some experiments and special types of demonstrations.

Departmental management. The Quebec Power Co. is also interested in the sale of farm electrical equipment. The promotional work is done by the "agronome" who specifies the type and the size of the machine most suitable for a job, but the farmer remains free to buy from any

distributor, since the company is primarily interested in the "load building" business. The service man employed by the company also takes care of selling the equipment at a non-competbting price. This utility is well known for its good service and for the good make of its electrical appliances which are recommended only after a careful investigation. This system seems to give very good results and leaves the "agronome" free to accomplish exactly the work he is supposed to do: help the farmers in their technical problems.

Type of lines and "load building". Some of the new rural lines are of the "common neutral" type carrying the current at 6900 volts. Distribution at 2300 volts is still popular. The kind of wire used is usually the copper-welded. Because of the low consumption of electricity on the farm the Company has felt the necessity of hiring "agronomes" to promote the utilization of electricity in the rural areas. These men, graduates of an agricultural college, are well trained to undertake the work of contacting farmers, although their knowledge in engineering is, perhaps, not as high as one would wish. However, their services have been recognized since the Company intends to employ two other"agronomes".

Resume. It arises from this study that the Quebec Power Co. has a rural electrification program which is actually under execution. It is certainly to be considered as an important asset in the rural electrification of the Province.

The Shawinigan Water and Power Co. In order to facilitate the administration of its vast territory, there are three different districts, namely: Trois-Rivieres, Victoriaville and Valleyfield. In each one of these, there is an "agronome" whose work is mostly directed towards "load building". It can be said, that he is the only one really interested in rural electrification since the organization of the company is such that no special department is provided for this field of activities. The "agronome" sometimes works under the district manager or sometimes under the sales manager, who can have two different understandings of the rural electrification problem. This arrangement results in making rural electrification a little at random and without efficiency. It should, therefore, be very desirable that this company establish an adequate program and create a special rural division in order to unify the work and bring the electricity to more farmers with less effort.

Policies of the company. The policies of this company regarding the extension of the rural lines are identical to that of the Quebec Power which has just been spoken of. It should be mentioned that the Quebec Power Co. offers special loans to farmers, to permit them to install electricity in their buildings. The same policy is followed by the Shawinigan Co. These loans are made without interest and are reimbursable by monthly installments, over a period of 40 months. Unfortunately only few farmers have taken advantage of these oppor-

tunities.

Rates. There is only one category of domestic rates offered to the farmers by this company. It corresponds to the first one of the Quebec Power, where:

Monthly fixed charge	22¢
First 40 kwhrs.	5¢ per kwhr.
Next 160 kwhrs.	2¢ per kwhr.
Balance	.9¢ per kwhr.

Minimum monthly bill: $1.00
Discount of 10% for payment within 15 days

These rates apply only to the farms where the total charge including motors and appliances (but not the charge in the house with the range) does not exceed 5 hp and the size of the largest motor is not bigger than 3 hp. These restrictions have the great inconvenience of limiting the utilization of electricity on the farm in permitting the usage of electric motors only for the rather small jobs, while the energy consuming operations in which the farmer would really need the economic help of electricity are left out. It would, therefore, be a great improvement in farm electrification if such rates and rules were revised.

Extension work. Because of a lack of a definite program and of an appropriate organization, the extension work is made somewhat accord-

ing to the good will of persons in charge of the work. Up to now the educational work has been confined to the publication of few booklets on wiring and to demonstrations of new electric devices. Very little has been done to utilize the great means of education like the radio, and the newspaper. These are two fields of action which should receive special attention. The teaching of rural electrification, at least of what belongs to the application of the electricity to the farm, in vocational schools and in agricultural colleges would be a powerful way of creating an "electrically minded" rural population.

The "load building" and type of lines. The "load building" has been and still is a problem by itself in this territory. Although, in 1942, the existing rural lines could serve about 19000 farmers, only 16,074 were connected to the lines, leaving about 3000 without electricity. It has been told to us that a company's representative, visiting farmers located along existing lines in order to persuade them to receive electricity, could each year collect about 400 new applications. Besides new consumers there is the question of increasing the consumption of electricity on the farm, which was, in 1942, only 33 kilowatt hours per month. There is yet a long way to go before reaching 150 kilowatt hours which is the monthly average for Ontario. It is certain that a good organization seconded by an extensive educational program would greatly help in that way.

The rural lines are still of the crossarm type carrying

generally 2,300 volts. It is said that their cost of construction averages $1200 per mile. Last year 300 miles of rural lines were built in various parts of the territory.

Resume. The rural electrification program of this company does not seem to be very definite. It extends new rural lines, it hires qualified men, it is true, but all these measures seem to be made all of a sudden without planning.

Other companies. Other companies like the Gatineau Power Co., the Southern Canada Power Co. are more or less interested in rural electrification. They extend their rural lines into the heavily populated countries and very often have prohibitive rates. They should, however, be concerned in a broad program regarding the whole Province and their participation in it should be looked for if the electricity is to be given to each farmer. The government owned "Hydro"-being not yet reorganized, falls in this category.

C. Organization of cooperatives of electricity

The presence of cooperatives of electricity in the Province of Quebec is something new. Last summer when this study was done, there was only one cooperative in operation, although there were 46 incorporated. It has been reported that by January 8, 1946, 69 electric cooperatives were established in 35 counties of the Province. This rapid development is due to the law of 1945, which created the Rural Electrification

Bureau. This organization by means of its personnel actively occupied itself to the application of the law. After less than one year of existence, the good results which have just been mentioned were obtained, showing that the rural people in Quebec were ready for rural electrification and that the law was waited for. This law provides for the establishment of a central Bureau which can:

1. Make loans to cooperatives of electricity up to 75 per cent of their value.

2. Assist and guide, by means of its staff, the same cooperatives in their construction, establishment, and maintenance.

3. Offer loans up to 75 per cent and not exceeding $500 for the cost of installation of electricity on a farm whose owner is a member of a cooperative.

4. Spend a sum not exceeding $12,000,000 for such a project.

The cooperatives refund the borrowed money by equal consecutive semi-annual installments calculated on an interest of 3% per annum on the initial amount and paid over a period of 30 years.

The loans made to farm owners for their electrical installation are "repayable in ten equal consecutive annual installments, the first whereof shall be exigible one year after the date of the loan with interest at 1% per annum, payable semi-annually."

This law well applied, should certainly promote the distribution

of electricity in rural areas. Whereas for the application of the electricity its success depends on the organization of the Bureau itself. The members of this Office must keep in mind this important point that the rural electrification is profitable to the cooperatives as well as to the farmers, inasmuch that they use electricity to the fullest extent on their farm. Otherwise the cooperatives would difficultly be self-supporting and the farmer would consider the electricity uneconomical since he will not take benefit of the lowest series of rates.

This point has been very well recognized in the United States where the R.E.A. had, up to 1940, a Division charged of promoting the use of electricity, which Division is now incorporated into the Cooperatives' Operations Division.

It would be too soon to criticize the present organization of this Bureau. It is not yet one year old, but we believe that it is the will of the members to follow the example of the R.E.A.

If it is true that there are 69 cooperatives which are incorporated in the Province, there is only one which is operating right now. This fact is due to lack of material and technical personnel. The cooperative of electricity of Saint Jean-Baptiste de Rouville, which is now operating, has been established under the law of cooperatives and later on transferred under the Rural Electrification

Act. It has been the first cooperative of this kind in the Province and its birth took place a year ago. We visited it during the summer quarter, and were able to collect the following information.

Cooperative of electricity of Saint Jean-Baptiste de Rouville. Located in the territory served by the Southern Canada Power Co. the farmers of this propperous parish tired of waiting for electricity. In 1945, 76 of them decided to found a cooperative of electricity, and through the medium of this organization to build 15 miles of rural lines, and buy at wholesale prices. Later on about 100 new members joined this first group and more than 16 other miles of rural lines were constructed. That was the status of the Cooperative when it was visited.

Management. This cooperative buys electricity at a wholesale price from the Southern Canada Co. The conditions were not yet known by September 12, 1945, because the Public Utilities Service still had the case on hand. It also purchases the electrical equipment for the patrons and benefits from a reduction in prices.

The manager is the secretary of another organization and provides an office in his house. He appeared to us as being not well prepared to assume such a job. His background in electricity seemed very low, and we wonder how such a man who does not know what a watt or a volt is, can efficiently advise and help a farmer in a problem regarding wiring, equipment, etc.... This individual case is

mentioned not to throw discredit upon a particular person, but to signalize a general gap which must be filled. It is sure that the other cooperatives formed are suffering with the same weakness since nobody has ever been trained for such work in the Province of Quebec. When one knows the part played by the manager in the success of a cooperative there is no hesitation to qualify this problem as very important.

Rates. This cooperative has two types of rates, namely: domestic and commercial. Under the domestic rates one is permitted to use a 5 hp electric motor. The cost is distributed thusly:

Fixed charge		$2.00
First	20 kwhr	4¢ per kwhr
Next	80 kwhr	2¢ per kwhr
Balance		1.5¢ per kwhr
Minimum monthly bill	50¢	

Commercial rates:

Fixed charge	$2.00
Any number of kwhr consumed	2¢ per kwhr

Even with a minimum of 50¢, the manager told us that there were still few farmers using not enough electricity, i. e. 12.5 kwhr to cover this amount. There is then a broad field for extension work. The patron has, moreover, to pay a bond of $100 to become a member. It is our belief that these are tentative rates and that they will be

revised as soon as the Rural Electrification Bureau becomes well organized.

Economy of this cooperative. The distribution lines have been constructed under contract, at a price of $2000 per mile. They are of the crossarm type and carry 2300 volts. The average density of the customers along the lines is 6. The balance-sheet shows in date of January 8, 1946, a profit of $728.73 on the sale of energy, and one of $1339.07 on the sale of equipments. This cooperative has received a loan of $40,000 from the R.E.B.

Resume. As this organization is entirely new, it must not be taken as a typical cooperative of electricity of the Province. In the near future others will appear, better favoured and better organized. They could certainly be advantageously compared to any similar cooperative elsewhere. But this success depends for a great part on the R.E.B. so true it is that "so much is the head, so much are the limbs."

D. Organization of the Agricultural Engineering Department in Agricultural Colleges.

There are in the province of Quebec three Colleges of Agriculture, more than 20 vocational schools and as many home economics schools. The Colleges of Agriculture: Ecole superieure d'Agriculture de Sainte-Anne-de-la-Pocatiere; Institut agricole d'Oka; and Macdonald College are each one affiliated with a university, respectively, Universite Laval, University Montreal, and McGill University. Besides small differences

the course arrangement is practically the same for the three Colleges. The first two years are spent on general subjects, while the student works on a special option in the last two years. These Institutions are mostly interested in teaching, and there is little extension or research work. These two activities being taken care of mostly by experimental farms, and the extension Service of the provincial government.

From the standpoint of agricultural engineering there is, properly speaking, only the Macdonald College which has a distinct department. In other Colleges this branch is more or less a part of the animal husbandry department. With this last set-up the course in Farm Buildings could be taught, for instance, under the course of Animal Production. This arrangement may have its advantages but we think that for the sake of convenience and of higher efficiency, the courses dealing with agricultural engineering should be grouped together in a special branch. The same remark could hold for the organization of the extension service in the provincial government. An entirely independant Agricultural Engineering Service should handle all the different problems pertaining to this field. The federal experimental farms in the Province have not, as yet, attacked this kind of research work. There would be, no doubt, a fine field of activity along that line.

The education in rural electrification has felt the effect of such an organization. No College gives a course in rural electrification

and this is not peculiar to the Province; it is the general situation in Canada. There is, however, a real need for qualified men in that field at the eve of the launching of great propaganda in favor of rural electrification. Utility companies are asking for more agricultural engineers; cooperatives want managers with a good knowledge of rural electrification; the provincial government through the Rural Electrification Bureau is presently looking for these men. Who will fulfill these demands if not the agricultural colleges? It is, therefore, of prime importance that these Institutions be prepared as soon as possible to provide such talent in order to insure the success of rural electrification in Quebec. Already Professor L. G. Heimpel, of Macdonald College, has approached a representative of a company on the subject. It is possible that through an organization similar to the "Virginia Farm Electrification Council" something could be arranged in the near future. The ideal would be, indeed, that the teaching, the extension, and the research work be centralized in the Colleges.

Once competent personnel will have been trained, it will be rather easy to persue the educational work. The vocational and home economics schools scattered all over the Province are propicious places to meet the farmer's boy and the future home demonstration girls and teach them the principles of rural electrification. It could also be possible in the "Classico-Menagere Schools" to train girls specially prepared to demonstrate the use and maintenance of the home electric equipment.

This training of qualified personnel is at the base of the application of any program and, therefore, a program in rural electrification should contain such an item.

E. Rural industries.

In 1941, the urban industrial production was 93.2 per cent of the total industrial production of the Province, leaving a percentage of 6.8 per cent for the rural industries. As small as this figure appears, it nevertheless represents the worth-while amount of $125,121,875, a sum which must not be disregarded after all. Unfortunately, the Quebec Statistical Year Book does not give any details on the rural industries. We know, however, having visited the whole Province, that there are almost everywhere small factories interested in one business or another. Rare are the villages whihh do not have either a creamery, a saw mill, a grist mill, or a woodwork shop. Sometimes all of them are found in the same locality. There are also, although in a smaller number, larger rural enterprises like canneries, fish processing plants, furniture factories, small foundries, etc.... it would be too long to name them all. If a calculation of the power required by these various enterprises was made, (and there is a need for it) one could find that they offer a good market for electricity. It can be safe to say that the average load for each factory would be 20 hp.

Now that there is a tendency towards the decentralization of industry, and that the companies want to establish their plants near

the source of the raw material, rural electrification will certainly favour this movement. While the distributing utilities will supply the required energy to these rural industrial establishments, they will in return receive a revenue which will help in balancing the rural electrification economy. This economical and social equilibrium which results from the rural industry, will certainly have good effects on the rural population as well as on the whole Province. The inter-relation between this problem and that of rural electrification is so close that the solution of one brings that of the other. Rural industries are, therefore, waiting for the development of rural electrification to expand normally.

F. Use of Electricity on Quebec's Farms

In general, it can be said that the use of electricity on Quebec's farms is confined to lighting and to the operation of a few household appliances, such as the washing machine, the electric iron, and the radio. Farm jobs requiring a great amount of energy, such as threshing, filling of silo, and wood sawing, are still performed with the gasoline engine. Large electric motors are practically unknown on the farm although small motors are beginning to be popular. In order to be acquainted with the situation and to know exactly what was the farmer's attitude towards electricity, a special survey was made. A typical range located at about 25 miles from Quebec city was, therefore,

chosen. The farms are prosperous although some poor ones neighbour rich ones. Because of their proximity to the city these farmers have a good opportunity to sell their milk on that local market. This situation probably represents an advantage over the general farms of the Province. The type of farming is, therefore, based on dairy, with few side crops. The farmers in fact told us that they were obliged to buy a great amount of supplemental feed like barley and wheat.

This range was electrified five years ago and some promotional work to encourage the farmers to use more electricity has been done. These are now convinced, and they regret their present installation on "two wires" which they wanted (against the recommendation of the company's representative) in the beginning because it was cheaper. They now realize that, for instance, the milk cooler is cheaper in operation than the harvesting of ice.

Such a district was chosen for our survey because the farmers having experienced the use of electricity, and having had the benefit of some educational work could express more exactly their personal thought towards this form of energy. It could, at the same time, give us a better idea of what promotional work can do in that field and also furnish us a basis for future tabulation.

Thirty-eight farmers of the IIIrd range of Saint-Michel de Bellechasse were, therefore, individually visited and questioned on

the size of their herd, their different electrical equipment, their electrical installation, etc...

Tables IX, X and XI give the average agricultural and electrical data which were collected during the survey.

Table IX.- Agricultural Data of the IIIrd Range St. Michel de Bellechasse P. Que.

Average size of farms	80	acres
Average size of wood lot	12	acres
Average yield in oats	450	bushels
Average yield in hay	83	tons
Grain bought: barley	6	tons
Grain bought: wheat	4	tons
Average number of cows	14	
Average number of heifers	7	
Average number of horses	3	
Average number of sheep	2	
Average number of hogs	4	
Average number of hens	214	

Table X.- Percentage of Major Electrical Equipment on IIIrd Range St. Michel de Bellechasse, P. Que.

Appliances	Percent Installed	Percent Desired
On the farm		
Clipper	39.5	10.5
Brooder	47.5	2.6
Grinder	5.5	2.6
Milk Cooler	47.5	9.7
Milking Machine	23.7	5.3
Small Motors	23.7	2.6
Large Motors	7.9	5.3
Water System	97.5	2.5
In the home		
Washing machine	97.5	2.5
Iron	89.5	5.3
Radio	76.5	10.5
Toaster	18.4	9.7
Refrigerator	7.9	9.7
Vacuum Cleaner	10.5	---
Hot Plate	13.2	5.6
Range	0	0

Table XI.- Electrical Data of IIIrd Range of S. Michel de Bellechasse, P. Que.

Item	Number	
Farms using less than 400 kwhr a year	35%	
Average annual consumption	975	kwhr
Average cost per kwhr	3¢	
Highest consumption	4632	kwhr
Lowest consumption	40	kwhr
Average " of farms having a 3 hp motor	3449	kwhr
Average " of farms having a milk cooler	1191	kwhr

It can be seen by the examination of these figures that this range has received a good impulse in rural electrification. The percentages given for the electrical equipment can be favorably compared with those of the United States, and since these men are now "sold" on electricity they desire new appliances. It can also be noticed that the most essential articles are in a high majority on these farms: water pump, washing machine, iron, radio. The presence of a rather high number of milk coolers on these farms is explained by the fact that the raw milk is sold in Quebec city, and that it has to comply with the regulations. Only three out of thirty-eight farmers have a large motor (3 hp) and they are those whose consumption of electricity is the largest. Their average consumption is 3449 kwhr and if it is compared to 1191 kwhr, the average consumption of the farmers having besides the usual electric equipment a milk cooler, it can be seen that the real consumption of electricity comes from the use of this energy as a source of power on the farm. There is presently in that district a campaign in favor of the 5 hp motor, and three of the visited farmers have expressed the wish to buy such a motor in the near future.

An analysis of these figures also reveals that, in spite of the educational work done, the average annual consumption is rather low; 975 kwhr. There are some reasons for that which must be taken into consideration in the application of a rural electrification program. Although these farmers receive a rather large income they

prefer to use the cheap manual-labor of their children, instead of electricity. Those take the place of the milking machine and of the small motors. Each farmer has a wood lot, averaging 12 acres, supplying all the fuel he needs for heat. The price of electrical equipment is, in general, very high so that the farmers can hardly afford it. The minds of these people are much more turned towards the education of their children than towards procuring non-essential machines. There is also much room for more promotional work. It is certain that any movement to reduce the price of these electrical equipments, would greatly help the consumption of electricity.

D I S C U S S I O N

The facts exposed under the heading OBSERVATIONS, give a good picture of the actual movement of rural electrification in the United States and of the present conditions and situation of the same activity in the Province of Quebec. Inasmuch as the rural electrification in the United States is scrutinized, it is observed that the program is built up around six main items as given by Muller:

"1. An effective plan for capitalization

2. Competent technical assistance in engineering, financial and system planning.

3. An increased education in consumer use of power.

4. The lowest possible wholesale energy, operating and consumer equipment cost.

5. Rate schedules of a pronounced promotional character.

6. The development over such areas as to make possible integrated, easily maintained systems, with sufficiently heavy loads and satisfactory revenues."

In the development of these items it has always been kept in mind that rural electrification is an agricultural as well as an electric utility enterprise. It is obvious that such a program, which is the result of 22 years of experience and research, which has permitted an increase of 30 per cent in the number of electrified farms in a period of ten years, and which will in the next few years step up this percentage to 80 per cent, would give good results in the Province

of Quebec. It must of course undergo some modification to be adapted to the Quebec's conditions, but our statement holds for the general principles already enunciated.

In the Province of Quebec rural electrification is just beginning. The power companies up to these recent years extended few rural lines in the heavily populated countries neighbouring the cities. They faced, and they are still facing the same difficulties that the distributing enterprises have met in the United States. The ways used in the latter to overcome the obstacles, ought to produce the same good effect in Quebec. Moreover, this Provinde seems to present two advantages for rural electrification; its large generation of electricity and the distribution of the rural population.

Although the cost of electricity in rural areas is mostly dependent upon the cost of the distribution, it is certain that the rates are influenced by the quantity of the production. The electricity supplied to the rural areas, can be considered on that standpoint, as a surplus and consequently be sold at a special price. This condition may exist in this postwar period where many industries have slowed down their production.

The Quebec farms are generally long and narrow; this shape favouring a high number of customers per mile of line. In the old parishes where the soil is good this situation prevails. In other

places the farms are distributed in river valleys, and the density of the population is usually sufficient to permit rural electrification. The worst problem would probably be to supply small settlements scattered almost anywhere and far from a small center.

In Virginia and in the United States three main institutions work together for spreading rural electrification: the companies, the co-operatives through the R.E.A., and the agricultural colleges. These agencies not only apply a well planned program but are also provided with an internal organization perfectly suited for this aim. In Quebec the same three institutions exist but they are not yet well organized to meet the needs of the hour. First, there is not what is considered the most important thing, a real rural electrification program concerning the whole province, and in which each unity would have a part to play. Secondly, because of this situation, the "individualism which kills" prevails. The companies have worked in their own district according to their means and their inspiration. The co-operatives have been interested in that field only for a few months, and the agricultural colleges never did care for creating a mentality or even for training specialists in that branch. Now the rural electrification crosses a period of groping because it has no rule or program to lean on.

The Rural Electrification Act of 1945 will improve the situ-

ation but unfortunately the cooperatives that this law favours, will need competent managers who are rather scarce now and still remain to be found. Moreover, the Rural Electrification Bureau created by this law will require in its organization well trained agricultural engineers, whom the agricultural colleges cannot educate at the present time. Finally, the law itself regards only one phase of fural electrification. It is, therefore, evident that a certain norm must exist in order that electricity be efficiently brought to the largest possible number of farmers. This norm lies in an adequate program where the education, the extension, and the experimentation, are the levers of action.

The experience of the United States has conclusively proved that there is progress in the application of electricity to rural areas in the proportion that these levers are closely working together. Details of their functioning have already been given in this thesis. They constitute a good example to be followed in the Province of Quebec.

The organization of the agricultural colleges on the triple standpoint of education, extension, and experimentation, would train all the necessary techniciane presently needed. It would help the county agents and the farm people in their rural electrification problems. The colleges, through research, could find or adapt new applications of electricity to the farm. The same arrangement with the power companies and the Rural Electrification Bureau, but mostly

for the education of farmers, is certainly an indispensable complement of the former.

The experimental farms of the Province would also offer an ideal medium for the education and the research. None of them has, at present, a section of agricultural engineering, but it is important that the Federal Government be alerted on the necessity of contributing to the promotion of the use of electricity on farms.

Rural electrification does indubitably help the rural industries to perform their activities as well as to lower their cost of production. It has even permitted the existence of new industries. The American experiments can be repeated in Quebec with no less success. The conditions lend themselves, probably better, to such enterprises, and even if it would only develop the existing industries, rural electrification could be recommended. There is, however, an industry which is, in our mind, very promising in the Province of Quebec: this is locker refrigeration. What we have seen in the United States allows us to forecast a wide spread of communal locker plants accompanying the extension of rural lines in the Province of Quebec.

That electricity lowers the cost of production, eases the farmer's work, helps the welfare of the family, is no longer to be proved. The Quebec farmers in general are convinced of these facts. They are, however, waiting for more education, new electrical applications, cheaper

electrical equipment, and possibly, for lower cost of electricity. Their first two demands could easily be fulfilled with the type of organization that has been proposed for the agricultural colleges, the power companies, and the Rural Electrification Bureau. As for new applications, it could be mentioned here that irrigation calls for great development in certain centers of the Province, particularly in those areas mostly interested in truck crops. It would supplement for the dry spell occuring practically every summer. The stationary sprayer for orchards may also be found of some utility. The"group purchasing" system for electrical appliances and their better adaptation to the farmers' needs would have the effect of reducing the cost of equipment. Although the cost of electricity is usually rather low in Quebec it can be said that there is yet room for lowering it.

In this post-war period where the authorities are looking for the readaptation of the industry to normal production, there is probably not a better partial solution than the application of an extensive rural electrification program. The construction of new lines, and the production of all the materials they would require will create a great demand for employment. This first step will in return initiate the wiring of houses, the purchasing and the installation of new electrical farm and household equipment, which activities will call for more work.

C O N C L U S I O N S

It has been found that the success and the survival of rural electrification, both for the distributing enterprise and the farmer essentially repose upon the use of more electricity on the farm. This is possible only if three principal conditions are fulfilled:

1. Low cost of electricity and of electrical equipment
2. Financial aid to the farmers
3. Extensive education and experimentation

In order to thoroughly achieve these conditions it is necessary that:

1. A rural electrification program for the Province of Quebec be elaborated.
2. A committee be appointed for that purpose.
3. This program involves agricultural colleges, cooperatives of electricity, power companies, and even experiment stations.
4. The three main fields of action: Education, Extension, Experimentation, be depended upon to make important contributions.
5. Certain standards in line construction and distribution, in rates, and in loans, be adopted.
6. Ways of lowering the cost of electric farm and household equipment be found.
7. Rural industries be considered as an important item of rural electrification.
8. The formation of a competent technical personnel, e. g. manager, agricultural engineer, be undertaken at the earliest convenience.

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APPENDIX

VIRGINIA ELECTRIC AND POWER COMPANY
FORM RD-RURAL DEVELOPMENT PLAN

PART I

The Company will extend its overhead distribution lines (normally not exceeding 15,000 volts) to Rural Domestic customers and Farm customers subject to the following conditions:

1. Extensions shall be single phase unless the Company elects to build polyphase lines.

2. Company will provide, own and maintain the line extension including poles, fixtures, transformers, wires and appurtenances required to extend its overhead system so that the Company's service wires can be attached to the Customer's building or other delivery point. Beyond this point of attachment, all additional wiring and all other facilities on the Customer's premises shall be provided by, and shall remain the property of, the Customer.

3. Applicant may be required to secure rights of way on private property without cost to Company, or assist Company in obtaining rights of way. Company shall be under no obligation to construct rural lines unless rights of way are so obtained.

4. Company will, under its general terms and conditions of service, construct, operate and maintain at its own cost, rural line extensions where, in the Company's opinion, the assured minimum monthly revenue for extensions constructed will amount to an average of not less than $6.00 per pole-line mile excluding service spans. The extension of lines on existing poles shall be counted in determining the pole-line mileage.

5. The assured monthly minimum for original and additional customers shall be not less than $2.00 per customer but in no event shall any Customer's assured minimum be less than the minimum specified in the rate schedule applicable to the service.

6. Customers connected will be served under applicable rates, terms and conditions of electric service as on file with the proper state regulatory commission.

7. Assured minimums shall remain in full force and effect for an initial period of one (1) year and thereafter unless and until service is discontinued, or this plan is modified through a future filing.

APPLICATION FOR RURAL ELECTRIC SERVICE

The undersigned requests VIRGINIA ELECTRIC AND POWER COMPANY to supply electric service to the premises located on the _____ side of _____ Road (Route_____) approximately _____ miles N-E-S-W from _____ in _____ County and occupied as a _____ and agrees to take and pay for same in accordance with the Company's Form RD-Rural Development Plan and Terms and Conditions of Electric Service as filed with the proper State Regulatory Commission; service to be billed on Schedule No._____; the minimum monthly payment to be $_____

Permission will be granted the Company to locate its pole line on my property.
Application binding after approval below by proper Company official.

Date _____

Approved—— Virginia Electric and Power Co.

_____
Signature of Applicant

By _____

_____
P. O. Address

_____
Mailing Address if other than above

_____
Company Representative

Property owned by_____

Eng. Est. No. _____

_____
P. O. Address

APPALACHIAN ELECTRIC POWER COMPANY

TARIFF D. S.

AVAILABILITY OF SERVICE.

Available for full domestic electric service through one meter to individual residential customers including rural domestic customers engaged principally in agricultural pursuits.

MINIMUM CHARGE.

The above tariff is subject to a minimum monthly bill of Two Dollars (2.00) for each meter installed, plus an additional minimum charge (for which the customer shall be entitled to use energy) of 50 cents per horsepower or fraction thereof for total rated capacity of each individual motor where such motor exceeds three-quarters horsepower.

DELAYED PAYMENT CHARGE.

The above tariff is net if account is paid in full within ten (10) days of date of bill. On all accounts not so paid, an additional charge of 5% of the amount billed (but not less than $.10) will be made.

TERM.

Annual Contract.

WATER HEATER SERVICE.

A-Where a customer has installed and in regular use a standard approved type of electric hot water heater of from 30 to 49 gallons capacity the last 240 kilowatt-hours used in any month shall be billed at the rate of 1 cent per kilowatt-hour.

B-Where a customer has installed and in regular use a standard approved type of electric hot water heater or heaters of from 50 to 74 gallons total capacity the last 360 kilowatt-hours used in any month shall be billed at the rate of 1 cent per kilowatt-hour.

C-Where a customer has installed and in regular use a standard approved type of electric hot water heater or heaters of 75-gallons total capacity or over the last 520 kilowatt-hours used in any month shall be billed at the rate of 1 cent per kilowatt-hour.

These provisions, however, shall in no event apply to the first 200 kilowatt-hours used in any month which will be billed in accordance with the "RATE" as set forth above.

RESIDENTIAL SERVICE

I. AVAILABILITY

This schedule is available to (a) single family residential customers (b) residential-farm customers and (c) private residences having only one kitchen or one set of cooking facilities and used as boarding and/or rooming houses. This schedule is not available to hotels, publi c inns and lodging houses as defined in Section 181 of the Tax Code of Virginia 1936.

The service used in each single family residence, boarding and/or rooming house, apartment or flat will be metered and billed separately.

II. MONTHLY MINIMUM CHARGE

$2.00

III. LOAD LIMITATIONS

(a) Motors having an individual rating in excess of 10 HP will not be served under this schedule.

(b) Loads creating a demand in excess of 25 KW measured over any period of thirty consecutive minutes will not be served under this schedule.

(c) Demand meters will be installed by the Company on any installation served under this schedule when it is estimated that the demand is 10 KW or more.

(d) When the measured demand in any month exceeds 10 KW, a charge of $2.00 will be made for each whole KW in excess of 10, which charge will be in addition to the charge for kwhr used, as specified in this schedule in Paragraph II.

VIRGINIA ELECTRIC COOPERATIVE

Schedule A

Rural Residential Service Rate

Availability:

Available to residential customers, residential-farm customers, schools and churches, located along the lines of the Company, for service including lighting, incidental appliances, cooking, refrigeration, water heating, and power for individual motors up to and including five (5) horsepower or a total meter load not in excess of seven and one-half ($7\frac{1}{2}$) horsepower, subject to the established rules and regulations covering this service.

RATE

First	30 Kwh. used per month @	7.0¢ gross, 6.0¢ net per Kwh.
Next	60 Kwh. used per month @	5.0¢ gross, 4.5¢ net per Kwh.
Next	60 Kwh. used per month @	3.5¢ gross, 3.0¢ net per Kwh.
Over	150 Kwh. used per month @	1.5¢ gross, 1.5¢ net per Kwh.

Minimum Monthly Charge:

The minimum monthly charge under the above rate shall be $4.00 gross, or $3.50 net, per customer in all cases where a single customer requires transformer capacity no greater than 5 KVA., except that for schools and churches requiring transformer capacity no greater than 5 KVA., the minimum charge shall be $2.50 gross, or $2.00 net.

When more than 5 KVA of transformer capacity is required, the above minimum charges shall be increased at the rate of $ .75 net per month for each additional KVA or fraction thereof.

In all cases the customer will be permitted to use energy for the minimum bill, computed at the above energy rate.

Prompt Payment Discount

The difference between the gross and net rates specified above shall constitute the discount for prompt payment, provided the monthly bill is paid in full not later than fifteen (15) days after the date of the bill.

VIRGINIA ELECTRIC COOPERATIVE

Schedule B

Rural Commercial and Power Service Rate

Availability:

Available to commercial and power customers along the lines of the Company for service including lighting, incidental appliances, cooking, refrigeration, heating, and all power purposes, subject to the established rules and regulations covering this service. Also, available to residential and residential-farm customers for any power service where individual motors exceed five (5) horsepower, or the total motor load is in excess of seven and one-half (7-1/2) horsepower.

Rate:

First	50 Kwh. used per month	@ 7.0¢ gross,	6.0¢ net per Kwh.
Next	200 Kwh. used per month	@ 6.0¢ gross,	5.5¢ net per Kwh.
Next	450 Kwh. used per month	@ 4.5¢ gross,	4.0¢ net per Kwh.
Next	1,500 Kwh. used per month	@ 3.5¢ gross,	3.25¢ net per Kwh.
Next	7,800 Kwh. used per month	@ 3.0¢ gross,	2.75¢ net per Kwh.
Over	10,000 Kwh. used per month	@ 1.5¢ gross,	1.5¢ net per Kwh.

Minimum Monthly Charge:

The minimum monthly charge under the above rate shall be $4.00 gross, or $3.50 net, per customer in all cases where a single customer requires transformer capacity no greater than 5 KVA.

When more than 5 KVA of transformer capacity is required, the above minimum monthly charge shall be increased at the rate of 75¢ net per month for each additional KVA. or fraction thereof.

In all cases the customer will be permitted to use energy for the minimum bill, computed at the above energy rate.

Prompt Payment Discount:

The difference between the gross and net rates specified above shall constitute the discount for prompt payment provided the monthly bill is paid in full not later than fifteen (15) days after the date of the bill.