THE ECONOMICS OF ELECTRIC POWER: DEMAND PROJECTIONS FOR NEWFOUNDLAND

PETER PODER

THE ECONOMICS OF ELECTRIC POWER:

DEMAND PROJECTIONS FOR NEWFOUNDLAND

© Peter Poder, B.A. (Hons.) Memorial

Submitted in partial fulfillment of the
requirements for the degree of Master of Arts

Memorial University of Newfoundland

April 1, 1969

Table of Contents

Chapter		Page
	ABSTRACT	i
	PREFACE	iii
	INTRODUCTION	1
1	HISTORY OF ELECTRIC POWER	4
	Definition of Energy	4
	Advantages of Electricity	5
	Features of Electricity	6
	History of Electric Generation	9
	History of Electric Power in Newfoundland	12
	Highlights of Electricity Generation in Newfoundland	13
2	PRESENT POSITION OF ELECTRIC POWER IN NEWFOUNDLAND	19
	Growth of the Electric Power Industry	21
	Transmission and Distribution of Power	37
3	ECONOMIC BASIS AND METHODOLOGY OF DEMAND PROJECTIONS FOR ELECTRIC POWER	49
	Economic Basis of Analysis	49
	Assumptions of Input-Output Analysis	53

Chapter		Page
	Techniques of Forecasting	57
	Input-Output Models of Atlantic Development Board and the Modification Necessary for Forecasting	62
	Final Demand and Value Added	70
	Linear Homogeneous Consumption Function	72
4	DEMAND PROJECTIONS OF ELECTRIC POWER	73
	Demand Projections by Input-Output Techniques	93
5	RECAPITULATIONS AND RECOMMENDATIONS	103
	APPENDIX 1	110
	APPENDIX 2	117
	APPENDIX 3	118
	APPENDIX 4	119
	APPENDIX 5	120
	BIBLIOGRAPHY	124

List of Tables

Table		Page
1	Installed Hydro and Thermal Electric Generating Capacity as at End of Each Year	23
2	Electricity Generation in Newfoundland From 1957 to 1966	25
3	Percentage of Power Generated Thermally	26
4	Power Generated by Individual Power Companies in Newfoundland from 1955-1967	28
5	Input-Output Flows - 1960	66
6	Input-Output Coefficients 1960	67
7	Projected Value Added for 1972	86
8	Adjusted Value Added for 1972	91
9	Input-Output Coefficients	95
10	Output Expansions (Not Including Household Sector)	97
11	Output Expansions (Including Household Sector)	100

List of Maps

Map		Page
1	Rural Electrification	35
2	Transmission Lines	41
3	Principal Hydro Generating Plants	42
4	Principal Thermal Generating Plants	43

List of Graphs

Graph		Page
1	Wages and Salaries	76
2	Forestry Value Added	77
3	Fisheries Value Added	78
4	Mining Value Added	79
5	Manufacturing Value Added	80
6	Construction Value Added	81
7	Electric Power Value Added	82
8	Gross Provincial Product	83

ABSTRACT

Power development is making news at the present time. Recently the generating capacity of the electric power industry in Newfoundland has been increasing quite rapidly due to the Bay d'Espoir Hydro project, and numerous other smaller power development projects. With the first phase of the Churchill Falls hydro electric development in 1972 nearing completion, the power generation potential of this province will again increase substantially.

It seems appropriate at this time, in the midst of these power developments, to investigate the present position of Newfoundland as regards to electric power, and to ascertain future requirements. In order for any planning in the electric power industry to be successful the future demand, as well as the supply, should be ascertained. The first step in planning, is one of the demand for power. The market must be analysed and the demand for power projected into the future. The controversy to-day is whether the future requirements for electric power in Newfoundland should be met by the transmission of power from Labrador (Churchill Falls) to Newfoundland, or whether the existing hydro and thermal plants should be supplemented by the construction of additional power projects on the Island. Before the decision can be made future power requirements should be estimated. If future demand is expected to increase rapidly

then it may be more economical to transmit power from Labrador or even construct a nuclear plant on the Island of Newfoundland. However if the demand will only increase slightly such measures are not appropriate.

The method of analysis employed in this thesis is the interindustry or input-output analysis. This method takes into account all the interindustry relationships and interdependancies. Instead of projecting power requirements by each sector of the economy and adding these together, we should take into account the whole interrelationships among the sectors of the economy, by means of the input-output table, to determine the ultimate demand.

PREFACE

In recent years much attention has been focused on electric power developments in Newfoundland. On the basis of vast power reserves the present policy has been to attract new industries into the province, especially new power intensive industries. With the emphasis on this policy it was decided that the actual demand for electric power created by industries, and also by households, should be quantified, and compared to the proposed generating capacity of this province. The projections were made for 1972, and it was found that under present plans shortages of power may actually occur, unless steps are taken to augment the proposed supply. At the present time final decisions on the transmission of power from Churchill Falls to Newfoundland have not been taken. The future electricity supply pattern in Newfoundland depends on this decision, for with the transmission of power ample supply will be available, but without the transmission, shortages are likely to occur until new generating capacity is installed.

Many people have aided in the research. I would like to express my gratitude to Dr. B. Singh of Memorial University who patiently guided me through the thesis. Other members of the Economics Department at Memorial have also given generous assistance, especially Dr. Y. Cho, who gave much valuable advice on the technical aspects of the thesis. Professor Wassily Leontief of Harvard University was of tremendous help, and spent several hours with me discussing many aspects of this thesis.

The people connected with the electric power industry in Newfoundland also contributed much of their knowledge. Mr. George Hobbs of the Newfoundland and Labrador Power Commission advised me on the general situation of the electric power industry, while Mr. Harvey Young was always available to provide the required statistical data.

Valuable assistance was also provided by the Newfoundland Light and Power Company Limited, especially from Mr. D. Templeton who explained many details of the present and past history of the electric power industry in Newfoundland.

I am also grateful to the Institute of Social and Economic Research for providing me with a grant for research purposes.

INTRODUCTION

At the present time Newfoundland is in the midsts of a great growth in electric power generation. From the beginnings of power generation in Newfoundland at the end of the nineteenth century when generation took place near the larger population centers we have now just reached the phase of the integrated power grid and large central generating station that should make electric power cheaply available to everyone in Newfoundland. Just last year the huge Bay d'Espoir power development was brought into operation to supply 1,350,000,000 kilowatt hours of electricity to Newfoundlanders, and this will again be expanded in 1971 to provide an additional 1,500,000,000 kilowatt hours of electricity. Of course with the completion of Churchill Falls which will be one of the world's largest hydro projects Newfoundland will really be a large producer of hydroelectric power. In 1966 (the latest year for which statistics are available) Newfoundland produced 5790 kilowatt hours per capita to make it the fifth largest producer of electric energy as compared to population size. Only British Columbia, Ontario, Quebec and Manitoba (in the order) ranked above Newfoundland.

This therefore seems like an excellent apportunity to review the electric power potential of this province, and to forecast future demand prospects. Newfoundland is at the present emerging from an economy based on primary industries such as fishing, logging and mining to a position where secondary manufacturing is emerging as an important factor in the economy of the province. These new industries are forecast to gulp up the power as fast as it can be provided. Especially large users of power will be the new petrochemical plant at Long Harbour and of course the paper mill as well as the petroleum refinery and the pulp and paper mill at Come by Chance. And not only these large industries but many small ones as well are being established in Newfoundland which will require more electric power in the future.

Not only industries, but private individuals as well will become greater users of power. In November of 1968 it was announced that uniform electricity rates would be established in Newfoundland. Thus although the price of electricity will be slightly higher in the urban centers of St. John's and Corner Brook, in the rest of the island electricity should be available at a cheaper rate. This will undoubtedly increase consumer's demand for electric services.

Along with the above factor it should be considered that the percapita income of Newfoundland has risen steadily and thus a higher income should induce more people to demand more electricity. With these increased incomes people will undoubtedly buy more electrical appliances. More leisure time will also be spent at home and hence this will force people to use more electricity. With the increasing popularity of electrical heating for households (at the end of

August, 1968 there were 875 residential and 965 appartment units using electricity for heating) will increase the demand for electricity.

The enlargement of the population will also increase the size of the market. Most important, not only will the population grow in absolute size, but the relative size of the population in the 20-35 age bracket will increase more than proportionately, and since these are the people who will for the most have greatest expectations, create a great many new residential units, and consume all goods and services including electricity at a greater rate, the growth potential for electricity consumptions in Newfoundland seems high.

Although forecasts for future power requirements of this province have been prepared by several different organizations such as the Newfoundland and Labrador Power Commission, and the Newfoundland Light and Power Co. Ltd., it seems appropriate at this time when Newfoundland is emerging as a great producer of electrical energy to compile a comprehensive report on the future electrical power potential of this province, and to make a comprehensive analysis into the future electricity demand by this province. The effect of this increased electricity production on other segements of the Newfoundland economy will also be analysed.

Chapter 1

HISTORY OF ELECTRIC POWER

Definition of Energy

Basically, anything with the inherent ability to perform work may be called energy. Thus in this sense there are many different sources of energy, such as human energy, animal energy, and all combustible materials. If we take into account the history of energy we can divide energy into two great periods: the age of predominant dependence upon animate energy and age of inanimate energy derived mainly from fossil fuels. To-day we in the Western World rely very little on animate energy. Most of our energy requirements are done by machines which use fuels. Very little actual work is performed by the muscles of man or animal. This is one reason for our great productivity. Energy contributes to industrialization and economic growth by animating tools and capital equipment. Capital equipment is the essential link whereby energy and industrial growth are related.

In Canada the five primary sources of energy that perform most of the work in the nation are oil, natural gas, coal, water power, and nuclear energy. And yet this thesis deals with electrical energy, and it is not even a primary source of energy! The reason electricity is not considered a primary source of energy, but as a secondary source, is because one or the other of the five primary sources necessarily must be utilized first in the commercial production of electricity. This is the unique characteristic of electricity. It can be produced from any primary energy source whether fossil fuel, nuclear, solar, wind, or water power. When the primary source is coal, oil, gas, or nuclear fuel the process of converting these primary sources of energy involves a preliminary process of release of heat which is to-day a highly advanced and sophisticated technology, utilizing most complex and precise processes, machines and equipment. This results in a very efficient conversion of very close to 40 per cent.

Advantages of Electricity

Electricity is a safe, economical, and clean means of providing energy services to the consuming public. For instance, it is much easier and safer to heat a home by electricity than by oil. Electricity also affords a continuous supply of energy to the home, as is not the case with oil heat for the household always has to call the supplying company in order to be provided with a continuous supply. In addition, it is much easier to plug in your electric kettle for a cup of coffee than to have to light an oil stove in order to be provided with the required heat.

Another advantage of electricity is that it can easily be transported over long distances. Once the capital cost of the towers and transmission lines has been borne then the cost of transmission of electricity is practually nil. This is one reason for the success of the central electric stations which shall be discussed in more detail later.

Perhaps the most important advantage of electricity is that it can be generated from both fuel or water power, depending on which is cheaper. Since electricity is a secondary source of energy this fact that it can be generated by various means from primary sources of energy is of great importance. If we are thinking of the long term future then the fact that some other means of primary energy may be exhausted, then it is reassuring to consider that because electrical energy can be generated by various means, electrification offers a particularly excellent route for the resolution of the problem of potential exhaustion of the mineral fuels. The importance of this fact that electricity can be generated by various means is of importance to Newfoundland at our present state of development since most of our major hydro sources have been tapped and for the future we have to rely on either thermal stations scattered throughout the island or transmit hydro power from Churchill Falls.

Features of Electricity

Electrical Energy has the unique feature in that it cannot be produced unless it is consumed. Indeed, although the elapsed time is instantaneous, electricity must be consumed before it is produced. By this we mean that a load must be present which sets in motion the complex equipment that will deliver the electric energy called for by that load. Thus the primary energy sources such as coal, oil or natural gas could be produced and then stored, but electricity can in no way be stored, except for the storage of small amounts in storage batteries. The unique feature of electricity is thus that it must be ready for use instantaneously as soon as it is called for by machines, tools, light fixtures, and other consuming devices.

Because of this feature of electricity that it must be available upon demand and cannot be stored, we run into various difficulties, the most important of which is the fact that demand for electric power varies according to the season and according to the time of day. Thus in determining the supply of electricity to be provided authorities must provide for "peaking," which signifies the time of day or season when demand is greater than average. The ratio of the average load, or demand for kilowatts, over a designated period to the peak load occurring in that period is termed the load factor. This is of great importance because the generation of electricity must be sufficient to provide for the demand during these "peak" hours, and hence in excess of the average load. In addition, excess capacity must be provided over peak load to allow for equipment "outages" necessitated by maintenance or break down. This is especially relevent in Newfoundland where the weather is an important factor to consider due to the high winds and the terrain of the country which offers very little protection to these winds. Of course this danger has been alleviated considerably lately with the announcement of an integrated electrical transmission system on the Island of Newfoundland consisting of facilities owned by the Newfoundland and Labrador Power Commission, Bowater Power Corporation Ltd., and the Newfoundland Light and Power Co. Ltd. With this integrated electrical system electricity can be fed from any of the eight generating stations around the island owned by the other three companiew. However this will be described in more detail when we shall discuss the historical development of power facilities in Newfoundland.

The ratio of the average load on the plant, for the period of time considered, to the aggregate rating of all the generating equipment installed in the plant is known as the "plant factor." The higher the average use of the plant capacity during a given period, the higher is the plant factor for that period. Of course the higher the plant factor the more efficient will the plant be, because an electric generating station has at all times to be able to supply the maxamium amount required from it.

Another unique feature to be taken into account when discussing hydro power (and much of electricity in Newfoundland is generated by hydro power; in 1967 out of a total production of 589,644 kilowatts on the Island, 470,990 were produced by hydro electricity, the remainder was by means of diesel or steam generation,) is that the flow of the stream being utilized for hydro power commonly varies over both long and short periods, reflecting rainfall and run-off patterns. However, the differences between short-period fluctuations in stream flow and desired variations in plant output can be overcome through the use of a small resevoir pondage for the plant.

However, in all of these sites there is usually a minimum flow below which the stream can be expected not to fall. The power capability that this flow and the available head represent is termed the "continuous power" or "prime power" that can be produced on this site. The function of this storage reservoir is to increase the minimum flow of the stream and hence also to increase the continuous power level.

History of Electric Generation

The first generation of electric power originated back in 1882, just three years after the development of the carbon filament incadescent lamp by Thomas Edison. In 1882 he placed in commercial operation the historic Pearl Street Station on Pearl Street, in the financial district of New York. In that year commercial electric service was begun with a load of approximately 400 lamps, each taking about 83 watts. A year later the number of customers had reached 513 with 10,297 connected lamps for a total load of about 860 kilowatts.

However, the discovery of electricity goes further back than that. In 1822 Seybeck made the basic discovery of thermoelectric generation. He found that a voltage was developed in a circuit consisting of two different metals such as copper and iron if the two junctions were maintained at different temperatures. Lately more progress into this method of generating electricity has been made and by supplying electric energy to a thermo couple or thermo pile we can produce either heating or cooling effects.

Several other methods of producing electricity were discovered at the time, such as thermionic generation which is the phenomenon of electron emmission from the surface of an electron-conducting material owing to the thermal energy of the electrons within the material. The fuel cell has been known since the 1840's when Sir William Grove discovered that electricity is generated when a fuel and oxygen are brought together in such a way that the energy which is to be released takes the form of an electron which is forced to travel around a circuit.

Although considerable progress has been made in the generation of electricity by the above methods, as of yet the promise of mass generation by these methods is not too great. Mass electrical generation has still to be done by either hydro, thermal or nuclear generation. As mentioned previously, the first commercial generation of electricity took place in 1882. By 1895 the modern electrical age can be said to have begun in North America when the Niagara Falls Power Company brought into operation a 5000 horsepower hydro electric station at Niagara Falls, New York. Previous to this, the so called Central Electric Station was only a dream, for in order to transmit electricity over long distances alternating current (AC) has to be used. Edison had only used direct current (DC) in his transmission, and for this reason the effective radius of transmission was not much more than half a mile from the power station. Because it is impossible to change the voltage of direct current once it is generated, direct current systems have to operate on the same voltage throughout, from generator to lamp. But for the home high voltage was dangerous and so a low voltage of about 110 had to be used. Because this low voltage could not be transmitted over long distances the beginnings of the central electric station could not take place until the invention of the transformer was made by means of which the voltage of an alternating current could be increased or decreased at will. Thus an alternating current could first be raised to a high voltage for transmission, thereby greatly increasing the economical transmission distance, and then reduced to a low voltage for distribution. With the advent of this new invention the central electric station came into its own, and these stations were able to take full advantage of the very large economies to be gained by the large scale operations.

History of Electric Power in Newfoundland

When electric power was first generated in Newfoundland at the end of the nineteenth century and the beginning of the twentieth century the generation always took place near the larger centers where the population was concentrated and where a ready market was available. Originally this generation was done by small companies who serviced their immediate areas. But as the demand for power increased these small companies were unable to finance larger power projects due to their limited financial resources. Thus the inevitable happened and they were acquired by the larger firms until to-day there are only a few companies supplying electricity on a retail basis, the major ones being the Newfoundland and Labrador Power Commission, Newfoundland Light and Power Company , and the Bowater Power Corporation.

In the initial stages of power development, generation was at 50 cycle frequency on the Western part of the Island and at 60 cycle frequency on the Avalon and Burin Peninsulas, which is standard for North America. The reason for the 50 cycle frequency on the Western part of the Island is that the two newsprint mills in Corner Brook and Grand Falls which produced their own power produced it at 50 cycle frequency because most of their machinery and equipment was acquired from Britain where the standard generation is at 50 cycles and hence the machinery was adapted to this frequency. However, with the development of the Bay d'Espoir power a decision had to be made whether to continue generating power at these two frequencies or whether to assimilate the whole process into the standard North American 60 cycle frequency. It was decided to generate and transmit power at the conventional 60 cycle frequency since it is now possible to have an integrated power grid for the whole island. For the purposes of this conversion the Atlantic Development Board granted $4,000,000[1] to convert the frequency at Grand Falls and Corner Brook.

Highlights of Electricity Generation in Newfoundland

Electricity was first generated in Newfoundland in the city of St. John's on September 15, 1885 and by October 17 of that year the first electric arc lights were lit in the stores. By November 1 of that year the streets of the city of St. John's were lit for the first time by electricity.

But to record a full history of this advancement, we must go back to April of 1885 when A.M. MacKay, superintendant of the Anglo American Telegraph Company in St. John's visited the Mainland of Canada. He was intrigued by the new wonder he saw - electric lights and thus he consulted with the Royal Electric Company of Montreal who stressed the merits of the Thomson Houston System of arc lighting and the fact that payment for equipment which Mr.

---

[1]Report of The Royal Commission on Electircal Energy, February 1966, P. 32

Mackay might purchase could be paid for by shares of the St. John's company. Up to then St. John's had relied upon gas light which had been installed a few years after 1844. By 1885 there were about 2,400 gas lights operating in the city of St. John's.

Following the visit of Mr. Mackay to Montreal a share list was opened on June 1, 1885 and in a few days the required amount of $32,000 was obtained in order to start the new company. The new company was set up in St. John's and by October it was possible for some stores on Water Street to be lit for the first time by electric light. This was the first time that electricity had first been generated in Newfoundland.

At that time no electricity could be transmitted to private residences because the type of lamp used - the arc lamp - was unsuitable for small rooms since it burned in an open globe consuming air and giving off heat. Its smallest production was 200 candle power and its main use, therefore, was for street and display lighting. In this initial phase of the system there were 28 lamps lit. The generator was a Direct Current machine with a voltage of 3,700 volts and its amperes of 10 Amps designed for a series circuit with each lamp requiring 50 volts to operate it.

As time progressed new lights and fixtures were added during the next few years, and by 1896 the St. John's Street Railway Company was incorporated by an Act of the Legislature of Newfoundland. This company was to be the fore-runner of the present Newfoundland Light and Power Company Limited. The tramway in St. John's was to prove to be a large customer for electricity generated in St. John's.

Thus in 1896 the Street Railway Company started construction of the Petty Harbour Hydro Plant which was to supply power for the operation of the tramway. This plant went into operation of Good Friday of 1900, with one 500 volt generator, and its power was transmitted over about eight miles of 15,000 volt transmission line to St. John's. Meanwhile, light to the city was still being supplied by the old steam generating plant but the St. John's Street Railway Company had been granted the right to sell any power not required for the street railway for lighting and other purposes and they soon took over the entire electrical load in St. John's. The steam generating plant was then dismantled.

The name of the company was changed to the St. John's Light and Power Company in 1920, and in 1924 it was again changed to the Newfoundland Light and Power Company.

In 1926 the plant capacity at Petty Harbour was increased by rebuilding the plant and also increasing the capacity of the transmission line from 15,000 volts to 33,000 volts.

The capacity of the company was then rapidly increased in the following years. The opening date and location of new generating facilities were as follows:

1931 - plant at Pierre's Brook, Witless Bay.

1942 - Tors Cove plant was opened with a capacity of 6,000 horsepower.

1943 - plant at Rocky Pond became operative.

1951 - the capacity of the Tors Cove plant was increased from 6,000 horsepower to 9,000 horsepower.

1951 - a 7,500 horsepower unit at Cape Broyle was installed and a 10,000 horsepower plant at Horse Chops was added in the same year. Also in that year the Newfoundland Light and Power Company installed a 2,500 kilowatt diesel plant in St. John's for emergency use in case of dry weather.

1956 - a 10,000 kilowatt steam unit was opened on the south side of St. John's.

1958 - the plant on the south side of St. John's was enlarged to a total capacity of 20,000 kilowatts.

The company was now solely an electric power company since the disbandment of the street car service in 1948. It was also growing. Although originally it was incorporated to service St. John's alone, it had grown as demand increased to service not only the additional areas in St. John's, but also the communities along the southern shore, and in recent years Gander, Grand Falls, and Corner Brook.

In 1951 the Newfoundland Light and Power Company purchased from the Bay of Islands Light and Power Company Limited and Bowaters Newfoundland Pulp and Paper Mills Limited the distribution system serving Deer Lake and the Corner Brook area. However, electricity in this area is supplied by the Bowater Company.

In 1956 the Newfoundland Light and Power Company acquired the electrical distribution system of the Anglo-

Newfoundland Development Company Limited in the towns of Grand Falls, Windsor, Bishop's Falls and Botwood. Since 1958 power for this area has been provided by the hydro electric plant at Rattling Brook which has a total capacity of 17,000 horsepower.

In 1962 another hydro electric plant was constructed at Sandy Brook, a few miles Southwest of Grand Falls. Also in the same year the Newfoundland Light and Power Company took over the former Department of Transport 3,000 kilowatt diesel plant at Gander. In addition in 1968 a 200 mile long 66 kilowatt transmission line was built between St. John's and Gander, enabling power to be sent from one system to the other as needed.

In 1966 five separate companies amalgamated in order to centralize management and integrate similar operating departments and to bring improved service to both urban and rural customers. The companies concerned were The Newfoundland Light and Power Company Limited, United Towns Electric Company Limited, Union Electric Light and Power Company, West Coast Power Company Limited, and the Public Service Electric Company Limited. As a result of this, power supply in this province is now not so decentralized as it has been in the past, when each town council supplied its own small district. This will in the future undoubtedly mean that more rational planning can take place to plan for the long run electric power demand and supply in this province.

To-day, the Newfoundland and Labrador Power Commission has the responsibility under law for the generation of hydro electricity throughout Newfoundland except where prior rights had previously been granted, such as the right of both the Bowater and the Price Newfoundland paper companies to generate their own hydro power. Transmission of power is provided by all three suppliers of power.

Chapter 2

PRESENT POSITION OF ELECTRIC POWER IN NEWFOUNDLAND

At the present time vital developments in the electric power industry are being undertaken in this province. Although a great deal of the population of the Island now have the modern conveniences of electric power, much controversy has risen in recent times over exactly how important is the provision of cheap and ample electric power. This thesis does not attempt to answer these questions.

This thesis proposes to present and discuss the future energy prospects of the province of Newfoundland and Labrador. Specifically, we shall deal primarily with the Island of Newfoundland. This seems quite reasonable when we consider that most of the energy absorbing industries are located in Newfoundland, and also most of the population make their homes on the island, so that the primary demand for electrical energy is generated on the island. When we are discussing supply, however. quite the reverse is true - much of the supply is generated in Labrador due to the development of the Churchill Falls complex which is scheduled to begin production in 1972 with the additional capacity of 2,300,000,000 kilowatt hours. The four stage Churchill development will take approximately eight years from 1972 to 1980 and add altogether 13,500,000,000 kilowatt hours to the electrical power capacity of the province of Newfoundland and Labrador. In more detail the planning of additional power blocks is scheduled to proceed in the following manner:

	Kilowatts	Horsepower	Kilowatt Hours
Stage I - 1972	300,000	400,000	2,300,000,000
Stage II - 1974	240,000	320,000	2,200,000,000
Stage III - 1977	540,000	720,000	4,500,000,000
Stage IV - 1980	540,000	720,000	4,500,000,000

Source: Newfoundland and Labrador Power Commission - Annual Report, 1967.

Because energy is of such vital importance to any country or province, it is essential that as much as possible be known about the longer range outlook in respect to the energy needs and the potential for satisfying these requirements. Our current knowledge of the future probabilities will permit more effective planning on the part of both the private economy and the government. However, it should be stressed in the beginning that any forecast on the future energy demand can only at best give a sense of direction - it will only tell us in a most general manner what the future probabilities are. This is the best we can do. With our given assumptions and basic data we can forecast the future pattern to the best of man's ability, but some unforseen circumstance can always decrease the accuracy of our estimate.

Before proceeding with our demand forecasts, however, this chapter shall analyse the present position of the power industry in Newfoundland, with an analysis of the recent growth in electric generation.

Growth of the Electric Power Industry

Two basic indicators are necessary to evalute the growth of the electric power industry: generating capacity[2] and power output. Their paramount importance scarcely needs elaboration, inasmuch as the pursuit of most economic and non-economic activity to-day is predicated upon the availability of electricity as a convenient form of power. However, electricity cannot be produced without adequate

---

[1] The term "generating capacity" is an ambiguous term which is difficult to define. Each power plant usually has a given rated capacity, which means that this is the maximum amount of power that it can generate if the plant is working at its full efficiency. Is this what we mean by generating capacity? But since by definition electricity cannot be stored and thus demand equals supply and this demand fluctuates over time, not only between different seasons of year but also at different times of the day, sufficient generating capacity must be available to meet the anticipated peak demand. Thus during the off peak periods the capacity used is bound to be less than the total available power supply. According to the Dominion Bureau of Statistics (Dominion Bureau of Statistics, Bulletin 1967, . 57-202.) net generating capacity is defined as "The maximum net kilowatt output (after station service) available from the generation facilities of the Utility System, or Industrial Establishment with all equipment available, at the time of the annual Firm Power Peak Load, determined as the average kilowatt output for one hour with no allowance for outages of generating units." In the above definition the phrase "After station service" is important to consider since at any time actual capacity to generate power may be substantially below the generating capacity due to the fact that some generators may be undergoing inspection or repair.

generating capacity and its efficient use. By the efficient use of electricity is not only meant the degree of operating efficiency of the individual generating plant, (efficiency of use in the narrower sense) but also the ability of the industry to make effective use of its total capacity, by such means as establishing inter connections that bring individual plants into one or more networks and reducing the variability of demand. Thus if we define efficiency of use in this manner, it can be said that the efficiency of use is a function of available capacity. In addition since electricity cannot be directly stored gross production and consumption (including consumption by the generating plants) are necessarily equal to each other during the same period of time. This does not of course take into account imports of electric power, which is non existant in the case of Newfoundland anyway since this province does not import any electric power. Consequently, given the degree of efficiency of use, the size of the total generating capacity is also the deciding factor in limiting current consumption. The growth of the generating capacity of Hydro and Thermal Electric Generating plants is given in Table 1.

We now turn to the growth of the output of power or electricity generation on the Island of Newfoundland from 1957 to 1967. The amount of power generated in Newfoundland during that period of time increased every year except in 1961 when the amount generated actually decreased from the

Table 1

INSTALLED HYDRO AND THERMAL ELECTRIC GENERATING CAPACITY AS AT THE END OF EACH YEAR.

KILOWATTS

Year	Hydro	Thermal	Total
1957	218,670	29,433	248,103
1958	245,530	34,196	279,726
1959	244,830	29,427	274,257
1960	257,430	56,264	313,694
1961	259,210	63,027	322,237
1962	352,810	65,327	418,137
1963	452,570	60,477	513,047
1964	452,770	60,190	512,690
1965	466,000	75,000	541,000
1966	466,000	113,000	579,000

Source: D.B.S. Electric Power Statistics, 1957-1966.

amount generated the previous year. The actual figures are given in (Table 2). (Table 3) indicates the percentage of electricity generated in Newfoundland that is generated by means of thermal equipment rather than hydro or water power. As can be seen only in 1966 did the percentage of thermal generated power exceed 10 percent of the total generation. The amount of power generated thermally increased only in those years when hydro power was not available, and heavier reliance had to be put on thermal generation. Of course with the availability of Bay d'Espoir power in 1967 the percentage of power generated thermally should have decreased, because of the availability of cheaper hydro power. The problems that had to be faced prior to Bay d'Espoir power were readily apparent to the Recent Royal Commission on the Economic State and Prospects of Newfoundland and Labrador. "Prior to the availability of Bay d'Espoir power, industrial expansion (particularly resource based expansion) was virtually at a standstill, and some industries had even been forced to curtail production until the first 200,000 horsepower of Bay d'Espoir came on stream in the spring of 1967."[3] However now that most of the power from Bay d'Espoir is being used, other alternative sources of power will have

---

[1]Report of the Royal Commission on the Economic State and prospects of Newfoundland and Labrador, 1967

Table 2

ELECTRICITY GENERATION IN NEWFOUNDLAND FROM 1957 TO 1966

Thousands, Kilowatt hours

YEAR	WATER POWER	THERMAL POWER	TOTAL
1957	1,313,396	62,313	1,375,709
1958	1,340,843	70,329	1,411,172
1959	1,370,826	77,812	1,448,172
1960	1,424,677	86,882	1,511,559
1961	1,320.552	137,008	1,457,560
1962	1,550,516	112,135	1,662,651
1963	1,946,874	122,730	2,069,604
1964	2,294,853	129,233	2,424,086
1965	2,497,965	270,544	2,768,509
1966	2,603,718	320,412	2,924,130

Source: Canada Year Book, Various Years.

Table 3

PERCENTAGE OF POWER GENERATED THERMALLY

YEAR		PER CENT	YEAR		PER CENT
1957	-	4.5	1962	-	6.7
1958	-	5.0	1963	-	5.9
1959	-	5.4	1964	-	5.3
1960	-	5.7	1965	-	9.8
1961	-	9.4	1966	-	11.0

Source: Canada Year Book, Various Years.

to be sought. The government is at the present time trying to decide on the best method of meeting the future demand. There are three choices available:

(a) Transmit power from Churchill Falls.

(b) Build additional Thermal Plants on the Island of Nfld.

(c) Harness additional hydro sources on the Island in order to increase the future supply of electricity.

If it is decided to continue to meet future demand by the errection of additional thermal plants rather than transmitting power from Labrador or harnessing additional hydro sources on Newfoundland then of course in the future the percentage of power that will be generated thermally will increase. Otherwise, however, with the wealth of water power readily available in Newfoundland, it is not likely that Newfoundland will experience the need for large thermal stations for some time to come.

In table 4 we again have the given historial data on the power generated in Newfoundland from 1955 to 1967. The data here has been compiled from statistics available from the Newfoundland and Labrador Power Commission, and they in turn have compiled the data from the Public Utilities Board, which is the regulatory board set up to regulate the Electric Utilities in this province. The data in table 4 is divided to show the source of the electric power generated. As can be seen, the figures for the total power generated in Newfoundland differs slightly between table 1 and 2. The

Table 4

Power Generated by Individual Power Companies in Newfoundland from 1955 to 1967

(Million Kilowatt-hour)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1. Nfld. and Labrador Power Commission													466.76
2. Nfld. Light and Power Co. Ltd.													
(a) NL&P Avalon Peninsula	156.33	184.29	186.57	186.56	200.14	210.04	224.65	225.13	237.44	260.19	294.38	355.01	315.29[1]
(b) NL&P Central Nfld.	-	-	-	1.45	35.78	38.35	43.05	47.68	54.43	64.04	70.60	-	81.72
(c) United Towns Electric Avalon	33.11	35.18	45.76	42.01	48.47	46.89	41.14	50.73	57.22	60.80	52.69	35.78	-
(d) United Towns Electric Burin												16.88	14.56
(e) Union Electric Light and Power	2.00	1.85	2.67	3.00	3.50	4.62	5.10	5.40	7.76	8.91	11.66	77.59[2]	39.45[3]
(f) Western Electric	19.73	19.96	18.20	16.08	19.15	21.41	33.49	26.45	28.08	29.96	31.33	28.33	36.07
3. Price Nfld. Limited	319.98	331.57	322.02	325.57	312.36	322.61	320.18	325.55	344.70	347.31	373.37	385.48	320.45
4. Buchans	0.45	1.03	1.33	2.51	2.91	2.95	3.24	2.31	3.00	3.20	3.18	6.56	7.36
5. Bowater													
(a) Hydrogeneration	763.33	770.31	728.62	737.62	745.53	744.93	663.52	790.76	810.28	820.51	815.51	841.79	572 29
(b) Gas Turbine	-	-	-	-	-	-	-	-	-	-	-	6.05	74.10
(c) Steam Generation	-	-	3.22	2.07	1.50	7.41	22:26	-	0.03	9.12	16.90	37.62	31.91
6. Little Bay Power	-	-	-	-	-	-	-	-	-	-	-	3.12	14.32
Total	1294.43	1399.19	1308.39	1321.87	1369.74	1340.24	1346.63	1474.01	1547.94	1601.94	1669.62	1744.39	1942.56

Source: Newfoundland and Labrador Power Commission.

Table 4 (continued)

1. This figure shows the combined total generation by the Newfoundland Light and Power Co. on the Avalon Peninsula and the generation by United Towns Electric on the Avalon Peninsula. Hence it is the sum of rows 2(a) and 2(c) for that year.

2. This figure shows the combined total generation by the Newfoundland Light and Power Co. in Central Newfoundland and by the Union Electric Light and Power Co..

3. Same as (2) above.

The confusion in the above figures results from the amalgamation of several of the power companies into one company - the Newfoundland Light and Power Company, and hence the generation figures filed with the Public Utilities Board are not as disaggregated as they were prior to the amalgamation.

reason for this is twofold. First, in the data supplied by DBS. (table 1) the generation of electricity would include the figures for Labrador. Electric Power is generated from two sources in Labrador[4] - Twin Falls and Menihek - both of which are hydro plants. However power from the hydro plant at Menihek is all sold to Scheferville in Quebec, with none of it being transmitted to Newfoundland. This of course is the main reason for the difference in the figures between the two tables. Secondly, it is probable that the utility companies take more care and accuracy in reporting their figures to the Public Utilities Board than they do when reporting to the Dominion Bureau of Statistics.

Rural Electrification

As electricity continued to be available to more and more people in Newfoundland, it was increasingly evident that because of the remote geographical location of many of the communities in this province it would become more difficult for the private companies to provide the facilities by means of which power could be supplied to the more remote settlements. However, some progress to rural electrification was started in 1954 when the Newfoundland Light and Power Company built its first line to service a rural area. Prior

---

[1] Newfoundland and Labrador Power Commission.

to that it had only served such urban areas as St. John's, Corner Brook and Deer Lake. But in 1954 they extended their services to Steady Brook in the Humber Valley and by the end of 1954 196 new rural customers were serviced by the Light and Power Company. This rural service was then continually expanded, with a transmission line being built from Corner Brook to Pasadena-Midland, Cox's Cove, and Frenchman's Cove and from Deer Lake to Nicholsville.

In 1956 the Newfoundland Light and Power Company acquired the distribution system of the Anglo Newfoundland Development Company in Central Newfoundland and the first rural line in central Newfoundland was completed by January of 1957 with 52 customers being connected. By 1958 with the acquisitions of the Gander and Lewisporte distribution systems and the completion of the Rattling Brook Hydro plant in 1958 furthur extensions into rural areas were undertaken.

As the settlements to be serviced became spread farther apart and more remote the cost to provide the required services increased tremendously. Because the number of customers per mile was low, and it would be uneconomic for the power utilities to construct lines, it became evident that some assistance from the government would be required. During 1958 a great deal of time was spent in examining the various ways in which government policy in the field of rural electrification might best be carried out. The government decided to have the privately owned utilities provide electric service in the more remote areas using distribution facilities built by the government, with the Newfoundland and Labrador Power Commission acting as the government's agent in this regard. This was to be done by the government deciding where electric power was to be supplied, and upon having decided the area, the government would ask the company responsible for the distribution of power in that area to submit a recommendation as to the most economical way of furnishing the supply, whether it would be by a small diesel plant, hydro plant, or by transmission line from the Company's existing system. The Company would then design and build the distribution and transmission lines and generating plants as maybe required for the purpose of supplying any designated area. Although the capital equipment which was thus constructed would be owned by the government the companies concerned were to be responsible for the operating costs of the lines and generating plants that it had constructed. However, when the power is generated by government diesel or hydro plants rather than from the existing distribution lines then the government would reimburse the Company for all expenses incurred in the generation of electricity in excess of two cents per kilowatt hour. It was also stipulated that the rates that would be charged to the customers would be such as they would be fixed from time to time by the Public Utilities Board. However, it was stipulated that included in the rates set by the

Public Utilities Board an "initial amount" was to be "collected on behalf of the government." In other words the companies involved would be refunded some of the cost that they had incurred, the amount of the refund being dependant upon the number of customers per mile of transmission line. The rates at which the refund would be granted are as follows:

9 or more customers per mile of line $1.20 per customer per mo.
Not less than 8 nor more than 9 per mile $1.00 per customer per mo.
" " " 7 " " " 8 " " 80¢ " " " "
" " " 6 " " " 7 " " 60¢ " " " "
" " " 5 " " " 6 " " 40¢ " " " "
" " " 4 " " " 5 " " 20¢ " " " "

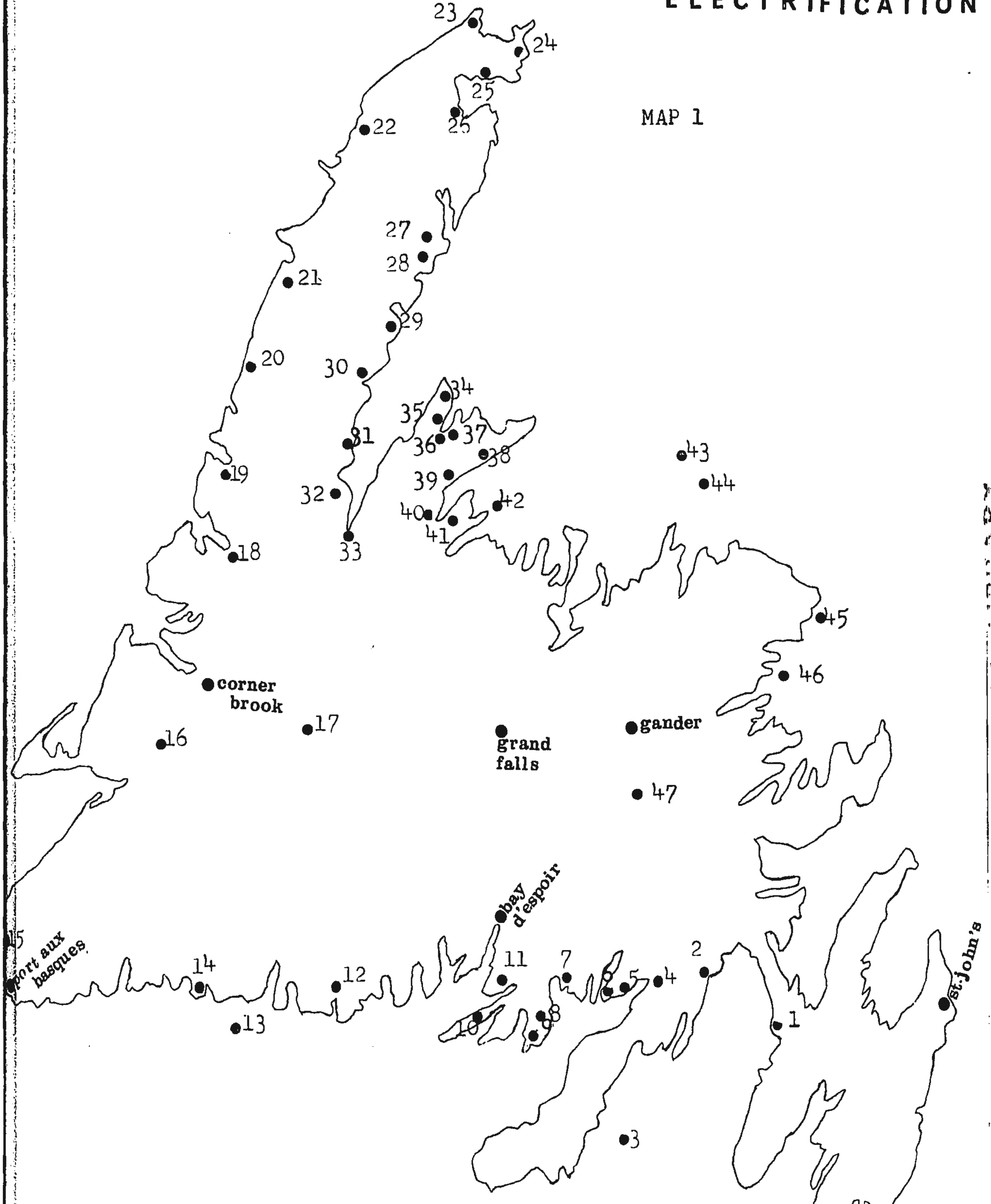
If in any month there were to have been less than four customers per mile on the average the refund would be the minimum monthly charge of the rate approved by the Public Utilities Board multiplied by the difference between the actual number of customers and the number there would be if there were four to the mile.

As the rural electrification program gained momentum during the next few years and as more of the small communities were serviced with electric power it became obvious that the method by which the government was reimbursing the private companies was becomming more complex. Although of course it was possible to ascertain the average number of customers per mile of transmission line this was becomming more and more difficult, and required more and more administrative personnel. It was thus decided in 1965 to change the whole concept of the rural electrification program. The government would transfer to the companies certain government rural distribution lines for the nominal sum of one dollar. It was also agreed that upon request of the government the companies would submit estimates of the cost of supplying electricity to a particular area and the probable number of customers that would be served. Then upon mutual agreement and on a shared cost basis the company would construct the necessary facilities to transmit power. The equipment would, however, now be owned by the company concerned for they were allowed upon completion of the project to acquire the power distribution lines, power distribution systems and substations, and any additions and extensions, for the sum of one dollar. The companies were now also responsible for any maintenance and operational costs that would be incurred. However the government retained the right to repurchase the equipment.

Map 1 shows the locations of the various plants in Newfoundland that generate electricity to the rural areas. The fourty-seven diesel plants used for rural electrification are mostly owned by the Newfoundland and Labrador Power Commission with only the one at Greenspond (45) being owned by the Newfoundland Light and Power company, although they

RURAL ELECTRIFICATION

MAP 1



SETTLEMENT LOCATIONS OF DIESEL PLANTS
USED FOR THE RURAL ELECTRIFICATION PROGRAM

Map 1 (continued)

1. Fair Haven
2. Woody Island
3. Port Elizabeth
4. Terrenceville
5. Grand le Pierre
6. English Harbor East
7. Rencontre East
8. Belleoram
9. Harbour Breton
10. Hermitage
11. Gaultois
12. Francois
13. Ramea
14. Burgeo
15. Cape Ray
16. Gallants
17. Millertown
18. Bonne Bay
19. Cow Head
20. Daniels Harbour
21. Port Saunders
22. Flowers Cove
23. Cooks Harbour
24. St. Lunaire
25. St. Anthony
26. Main Brook
27. Roddickton
28. Englee
29. Hooping Harbour
30. Harbour Deep
31. Jacksons Arm
32. Sop's Arm
33. Hampden
34. Fleur-De-Lys
35. Coachmans Cove
36. Mings Bight
37. Pacquet
38. Nipper's Harbour
39. Burlington
40. King's Point
41. Harry's Harbour
42. Little Bay Islands
43. Change Islands
44. Fogo
45. Greenspond
46. St. Brendans
47. Terra Nova

do own other diesel plants in Newfoundland that are used on stand-by-basis.

Appendix 1 shows the present number of customers, the miles of line, and the voltage of these lines that are presently being used under the rural electrification plan. The date when these came into operation is also shown.

It is estimated by the Newfoundland and Labrador Power Commission that by March 31, 1969 the capital invested under the rural electrification plan will total $20,386,445.00. This includes $10,432,788 given as "Grants-in-Aid" and $9,953,657 in loans.

Transmission and Distribution of Power

In the commonly used economic terms, electricity caters both to direct consumption and to the production of goods. As a consumer's good, the consumption of electricity tends to increase with an increase in the income, and as an input in the production process its availability is a prerequisite to a rising income. Thus for industrial progress the availability of abundant electric power is of prime importance to future growth. As of January 1, 1967 the undeveloped water power resources[5] of Newfoundland (including Labrador,) was estimated at 20,923,000 kilowatts at Q95[6] and 65,006,000

---

[1] Canada Year Book, 1968, P. 663

[2] The natural or modified flow available 95 per cent of the time.

kilowatts at Q50.[7] The figures of continuous power at Q95 represent only the minimum water power possibilities because estimates are based on existing river flow and, for the most part, do not reflect the benefits of stream flow regulation that would result from the development of storage potential. In fact, thus, the potential undeveloped hydro resources may be even greater than that stated above.

Thus, because of the availability of ample power it can be assumed that the demand for power, both industrial and household, will increase quite substantially in the future. However, electric power will only be used if it is readily available, and available with the minimum of disruptance. This section thus deals mainly with the existing transmission facilities available, in order to ensure that a reliable and efficient supply of electricity is available. If it can be assured that this is available then more and more industries can be induced to locate in Newfoundland.

High voltage transmission is provided by the Newfoundland and Labrador Power Commission, the Newfoundland Light and Power Company Limited, and Bowater Power Corporation. The distribution of electricity on the other hand is the responsibility of Bowaters, Newfoundland Light and Power Company Limited and the Rural Electricity Authority which is a Crown Corporation administered by the Power Commission.

---

[1]The natural or modified flow available 50 per cent of the time.

Transmission of power is the function of carrying electric power to load centres and large users beyond the economical service range of the primary distribution lines. Distribution lines are lines set up to distribute power from the bulk power sources (generating stations or substations supplied by transmission lines) to the consumer's service switches.

At the present time the main transmission system from Bay d'Espoir to St. John's and from Bay d'Espoir to Grand Falls, Springdale, Corner Brook, Stephenville and Port aux Basques is also connected to all the other hydro generation sites on the Island of Newfoundland. There has thus been achieved a connecting link so that if power generation from any of the existing hydro stations is disrupted for some reason then due to the existing interconnecting link power can be relayed to the area from one of the other existing hydro sites. However, this of course does not mean that no outages will occur in the future, for the danger that a breakage in one of the transmission lines may occur at any time still exists. No matter how much duplication there may be this uncertain factor still poses a problem. In reality, of course, we cannot insure against all uncertainties, and the more insurance we do have the greater the cost. Thus we have to make a compromise between the amount of money we wish to lay out for insurance and the costs involved. In the electrical utility industry this means that we have to make a compromise between the number of duplicate lines to build to insure no breakage in the transmission of power, and the reality that with more duplicate lines the costs will increase and thus the price of electricity to the consumer will increase. If the price of electricity is driven too high in this manner it will rise beyond that which the ordinary person can afford, and we will have gained nothing.

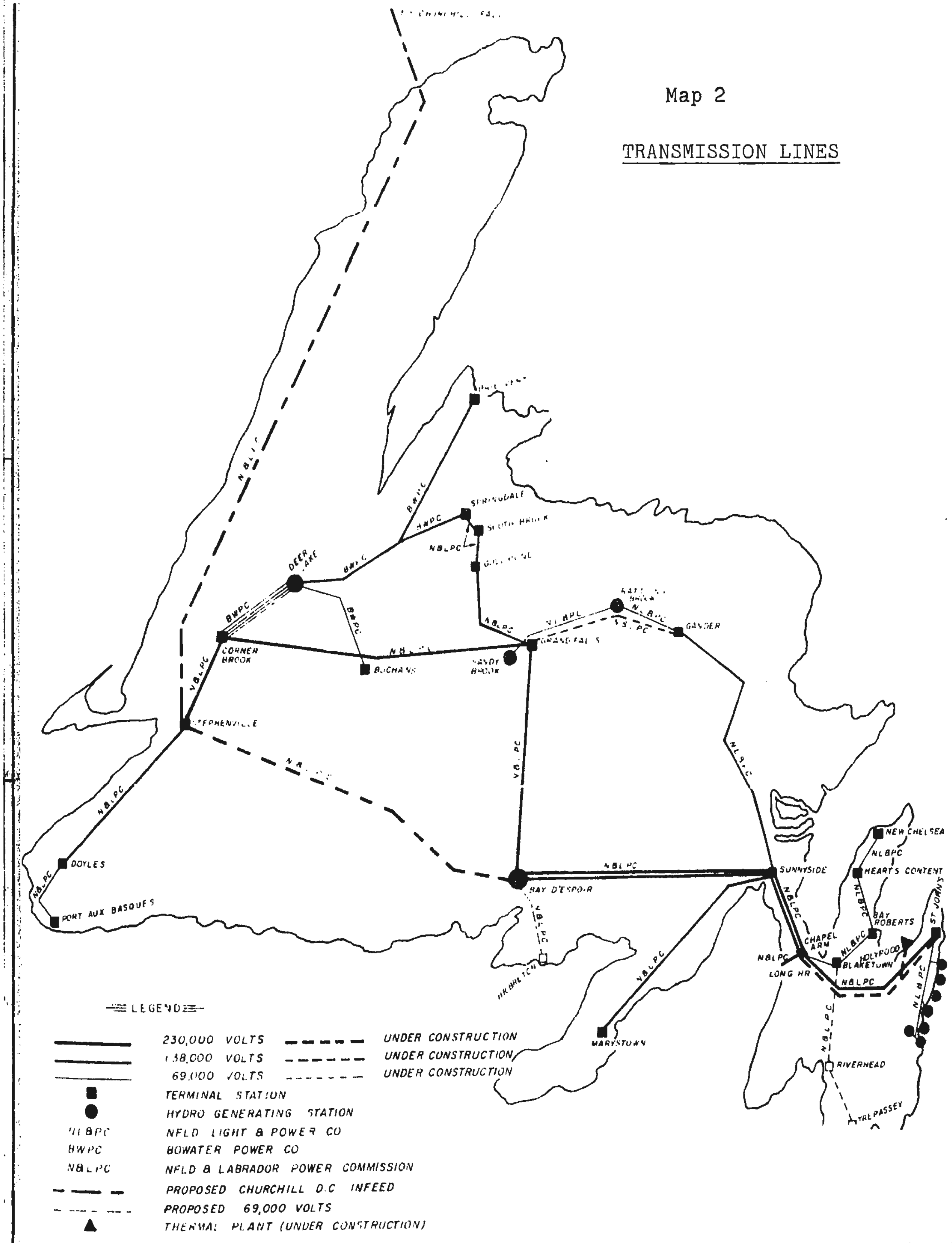
Map 2 shows the existing power grid in Newfoundland, with the transmission lines owned by the individual utilities marked; the voltage of the lines is also shown, as well as the main terminal stations connecting the power grid. We can also see the main Churchill Falls Transmission line from Stephenville to Labrador which has been proposed and will be constructed if and when it is decided to transmit power from Churchill Falls to Newfoundland. However, because of the tight money situation it is not expected that the power link between Newfoundland and Labrador will be completed this year.

In Newfoundland at the present time the integrated electrical system consists of various hydro and thermal plants situated throughout the island. The maps on the following pages (Map 3 and Map 4) show the locations of the hydro and thermal generating plants in Newfoundland. Included are:

1. A large hydro plant at Deer Lake with a capacity of 170.000 horsepower owned by the Bowater Power Corporation.
2. A hydro generating station at Watson's Brook owned by

Map 2

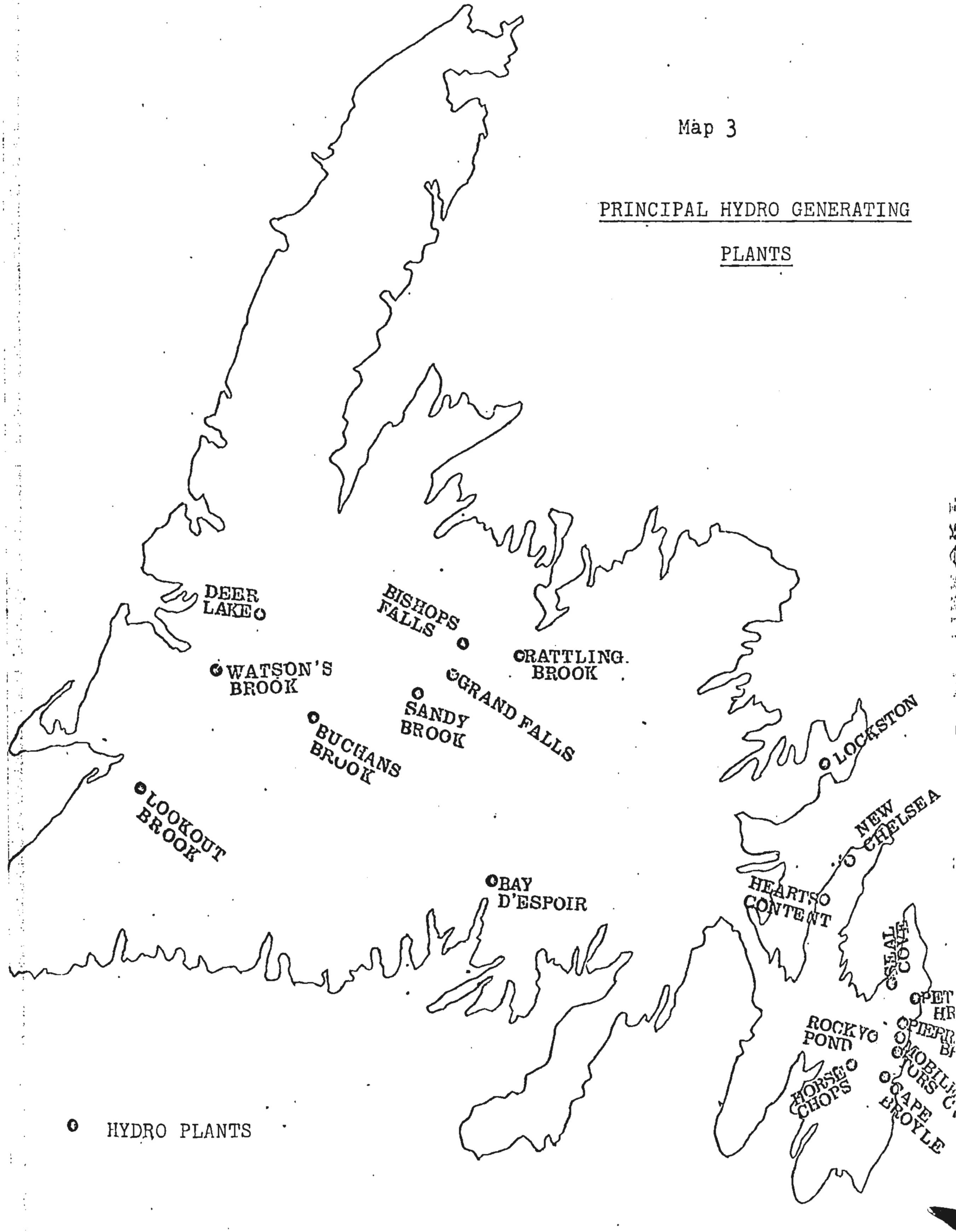
TRANSMISSION LINES



Source: Newfoundland and Labrador Power Commission.

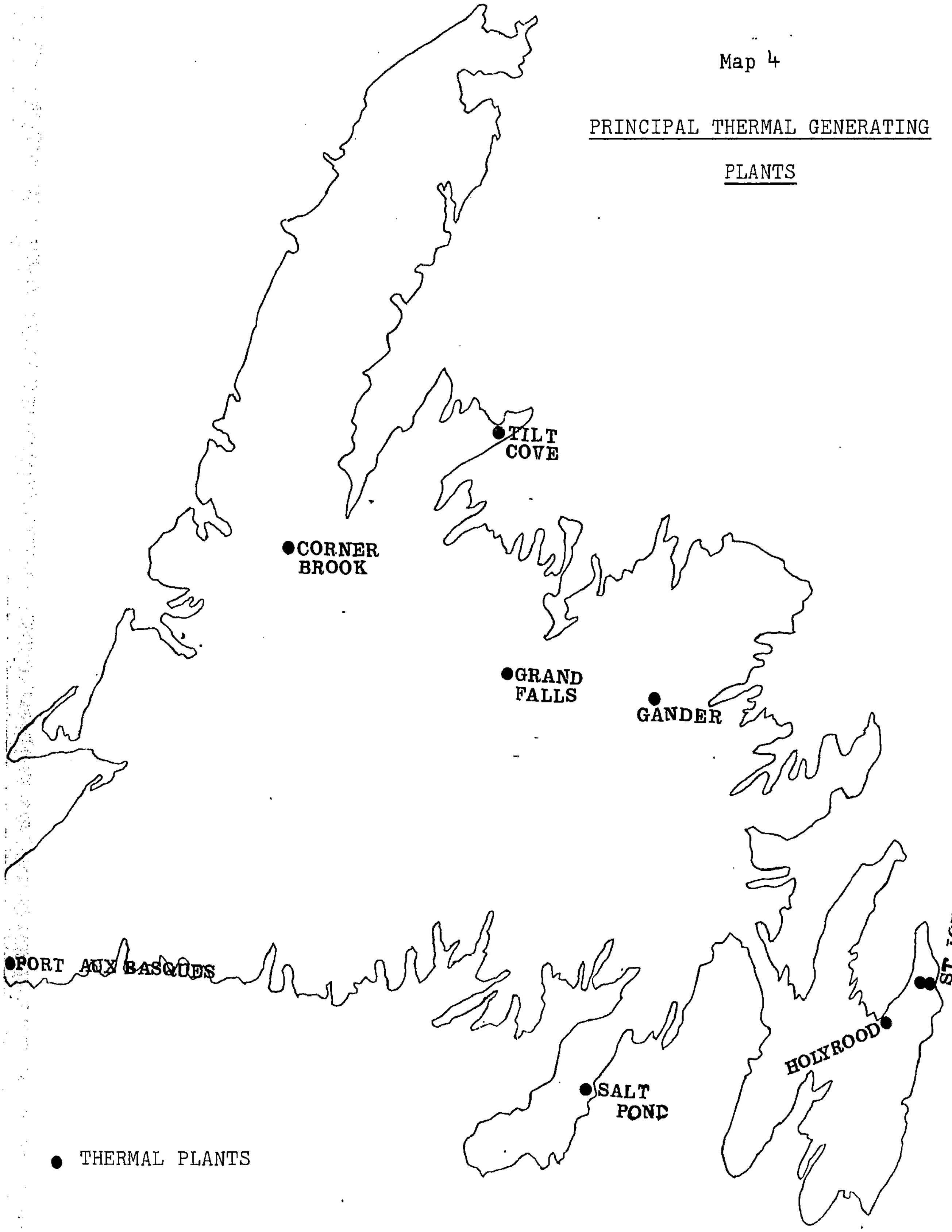
Map 3

PRINCIPAL HYDRO GENERATING PLANTS



Map 4

PRINCIPAL THERMAL GENERATING PLANTS



● THERMAL PLANTS

Bowater Power Corporation with a capacity of 12,000 horsepower.

3. The hydro generating station at Bay d'Espoir owned by the Newfoundland and Labrador Power Corporation with a capacity of 400,000 horsepower.
4. Hydro generating stations at Rattling Brook and Sandy Brook (capacity of 26,000 horsepower) owned by the Newfoundland Light and Power Co. Ltd..
5. A hydro generating station at Lockston on the Bonavista Peninsula owned by the Newfoundland Light and Power Co. Ltd. with a capacity of 4,000 horsepower.
6. Various hydro generating stations on the Avalon Peninsula owned by the Newfoundland Light and Power Company Limited. These various plants are located at New Chelsea, Hearts Content, Seal Cove, Rockey Pond, Horse Chops, Petty Harbour, Pierre's Brook, Mobile, Tors Cove, and Cape Broyle. The combined capacity of these plants is 70,000 horsepower and estimated at 220,000,ooo kilowatt hours in 1968.
7. Hydro Plant at Lookout Brook owned by the Newfoundland Light and Power Corporation.
8. Other Hydro Plants not connected to the power grid are owned by Price Newfoundland Pulp and Paper Company Limited, who own plants in Grand Falls and Bishops Falls, and a hydro plant in Buchans Brook owned by American Smelting and Refining Company.

9. Thermal Plants which supply power to the power grid are located in St. John's, owned by the Newfoundland Light and Power Company Limited with a capacity of 40,000 horsepower and estimated at 225,000,000 kilowatt hours in 1968, and a Gas Turbine unit on the Avalon Peninsula at St. John's owned by the Newfoundland and Labrador Power Commission which has a capacity of 20,000 horsepower and was estimated at 100,000,000 kilowatt hours in 1968.

10. Other Thermal Stations in Newfoundland are situated in Port aux Basques and Salt Pond which are owned by the Newfoundland Light and Power Company Limited, in Corner Brook owned by the Bowater Power Corporation, in Grand Falls owned by Price Pulp and Paper Company Limited, and in Tilt Cove owned by the Tilt Cove Power Corporation. There is also a thermal station located in Gander and owned by the Department of Transport but it is used only in case of emergencies on a stand by basis. In addition the Newfoundland and Labrador Power Commission is building a thermal plant near Holyrood which will have a capacity of 300,000 kilowatts of electricity. The purpose of this plant is to supply electric power to meet the anticipated demand which cannot be met by the Bay d'Espoir hydro plant. In the event that Churchill Falls Power will be transmitted to Newfoundland this plant will go on stand-by and be

available for "back-up" power for the east coast of Newfoundland.

Well over half of the power from the above generation can be fed into the electrical grid. This consists of:

1. 120 miles of 230,000 volt line from Bay d'Espoir to Chapel Arm. This consists of two complete lines.
2. 55 miles of 230,000 volt line from Chapel Arm to St. John's. One line is complete and the second one is under construction at the present time.
3. 208 miles of 230,000 volt line from Bay d'Espoir to Grand Falls, Corner Brook, and Stephenville. One line is used at the present time and a second line to Stephenville is under construction.
4. 71 miles of 138,000 volt line from Stephenville to Doyles.
5. 22 miles of 69,000 volt line from Stephenville to Doyles.
6. 62 miles of 138,000 volt line from Grand Falls to Springdale.
7. 86 miles of 138,000 volt line from Sunnyside, Trinity Bay to Marystown.
8. 98 miles of 138,000 volt line from Sunnyside to Gander.
9. 55 miles of 69,000 volt line from Gander to Grand Falls. This line is now being rebuilt to 138,000 volt line.
10. 55 miles of 69,000 volt line from Whitbourne to Trepassey.
11. 32 miles, 4 circuits of 69,000 volts from Deer Lake to Corner Brook (3 circuits of 50 cycles, and 1 circuit at

60 cycles.)

12. 72 miles of 138,000 volt line from Deer Lake to Springdale.
13. 42 miles of 138,000 volt line from the Indian River Substation to Baie Verte.
14. 47 miles of 69,000 volt line from Deer Lake via Howley to Buchans.

The power generated by the various hydro and thermal plants accross Newfoundland can be fed from the main transmission lines into the various distribution systems at the following points:-

1. Port aux Basques
2. Doyles Codroy Valley
3. Bottom Brook, St. George's Bay
4. Corner Brook
5. Deer Lake
6. Grand Falls
7. South Brook
8. Springdale
9. Gullbridge
10. Bay d'Espoir
11. Sunnyside
12. Chapel Arm
13. Whitbourne
14. St. John's
15. Marystown
16. Gander

17. Bay Roberts
18. Clarenville
19. Baie Verte
20. Buchans

With these developments there is now more insurance that less power failures will take place in the future and that the means of back-up power are available in the Port aux Basques area, Corner Brook-Stephenville area, Grand Falls-Gander area, the Avalon Peninsula, and the Burin Peninsula. In the case of the Avalon Peninsula power can be fed from Bay d'Espoir, the thermal and hydro plants operated by the Newfoundland Light and Power Company, or by the Gas Turbine plant operated by the Newfoundland and Labrador Power Commission.

On the Burin Peninsula power can be partially supplied by the diesel plant in Salt Pond, and for additional stand-by power the Newfoundland Light and Power Company in December 1968 completed construction on a 14 megawatt gas turbine plant at Salt Pond on the Burin Peninsula which has a capacity of 14 megawatts. This plant will provide additional back-up power so that if there is any disruptance in power flow from the existing island network additional means will be available whereby electric power can be generated to the Burin Peninsula.

Chapter 3

ECONOMIC BASIS AND METHODOLOGY OF DEMAND PROJECTIONS FOR ELECTRIC POWER

In our modern society electricity is of vital importance to everyone. How true this fact is can easily be seen when during the year there may occur due to an unforseen circumstance an interruption in the transmission or distribution of electric power. Most people cannot heat their homes nor even eat a hot meal. Many industries, especially the ones where electric power is an important input, also have to curtail production. Due to the importance of electric power the authorities have to plan carefully in order to ensure that the continued future supply of electricity is assured. Therefore appropriate demand forecasts have to be made in order to ascertain what the future demands may be.

Economic Basis of Analysis.

Basically, there are two distinct methods of economic analysis. We can either discuss the economy as a whole (macro-economics) or we can discuss the smaller individual sectors that make up the economy such as the analysis of the behavior of an individual firm (micro-economics.) In the history of economic analysis both methods have been applied exhaustively by different writers. Adam Smith, who is regarded by most as the first great economist dealt exclusively with macro-economic ideas, as indeed we can discern by just looking at the title of his "An Inquiry into the Nature and Causes of the Wealth of Nations."

Later economists such as Alfred Marshall and those who followed him in the "Neoclassical School" were more concerned with the micro aspects of the individual and the firm. Although their theories were modified by others no new radical thought was injected into economics from the time of Marshall's "Priniciples of Economics" until Keynes wrote his "General Theory of Employment, Interest and Money" in 1936, which again dealt with the macro-economic method of analysis.

The Neo-classicals had been concerned with partial equilibrium, or of examining one thing at a time, while Keynes was interested in general equilibrium in aggregate. He deals with total national income as it is affected by total saving and spending. But neither the Neo-classical economists nor the Keynesians were really concerned with economic interdependence between the different sectors of the economy or of the structure of the economy.

However back in 1758 Francois Quesnay, one of the early French Physiocrats, had published his "Tableau Economique" which as Miernyk[1] has pointed out in his book on Input-Output

---

[1]Miernyk, William H., The Elements of Input-Output Analysis (New York: Random House, Inc., 1965) P. 4

Analysis showed the successive "rounds" of wealth-producing activity which resulted from a given increment in output. In this sense it ressembles modern multiplier analysis.

In 1874 when Leon Walras published his "Elements d'Economic Politique Pure" we enter into the real phase of general equilibrium analysis because he was interested in the system as a whole. He succeeded in linking together two markets: the market for goods; and the market for services of the factors of production. This did not imply a market for only a single commodity but for all commodities and for all productive factors. He visualized the whole economy as a series of interdependent markets, with demand, supply, and price influencing one another and also what he called "the productive services" of the factors.

Walras used mathematics, especially algebra and calculus, and mathematical terminology to express economic relationships and functions. The reason for this was his belief that economic relationships could be precisely stated and then proved. His aim was to raise the level of economic analysis to that of a pure science, and because of that he wanted to express his theories in Mathematical terms. Vifredo Pareto, who was the successor to Walras at the University of Lausanne also contributed greatly to the "general equilibrium" method of analysis. Both also used the term "Pure Economics" which meant that economics could become an exact science.

In the 1930's Wassily Leontief greatly refined the work of these earlier economists by his work with the input-output tables for the American economy. "Input-Output analysis... is the name given to the attempt to take account of general equilibrium phenomena in the emperical analysis of production."[1] The system developed by Walras was a purely theoretical model and did not easily lend itself to empirical verification. The method as worked out by Leontief, however, is of great practical value. The basic value of the Leontief system is that it explicitly shows in a square matrix the interdependence of each sector of the economy on every other sector. It is a technological relationship, as it shows under a given technology what is produced and how it is produced. It shows what inputs are required by each of the industries in order to produce its output, bearing in mind always the fact that the input for each industry is an output from some other industry. These input-output tables originally developed by Leontief could be aggregated to include only a few sectors of the economy as has been done in this thesis or disaggregated almost in an unlimited manner. Input-output tables have been constructed as large as 200 by 200 or aggregated to a smaller size, as has been done in this thesis.

The Leontief system is thus diametrically opposed to the theories of the "Austrian" economists. Their idea was that you can identify certain industries as being in earlier stages

---

[1]Baumol, William J., Economic Theory and Operations Analysis (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1965) P. 479

of production and other industries in later stages, and that one product is solely sold to one particular seller. However, Leontief in his input-output analysis finds that you have to consider the whole interrelationships between the various different industries.

Assumptions of Input-Output Analysis

Certain assumptions employed in input-output analysis are subject to criticism. However, it is also suggested that in an imperfect world nothing is subject to the ideal of perfection, and perhaps the errors inherent in the input-output method of forecasting are less than the errors which crop up when other methods are utilized.

One assumption that is made in input-output analysis is that no two commodities are produced jointly. Thus each industry produces only one homogeneous commodity. This can and does pose difficulties when we consider that our modern large corporations produce a wide variety of goods, so that it is in some cases difficult to classify a particular industry. Thus the best solution we can have for this problem is to classify a firm according to its principal product.

A second more serious criticism of the Leontief system is that the system is static, rather than dynamic. With a given technology all inputs are used in fixed proportions and the use of these inputs expands in proportion with the level of output. Thus a linear homogeneous production -

function (constant returns to scale) is assumed. Although the theory of constant returns to scale is perfectly consistent with the classical ideas of substitution as shown by Clark, Wicksteed, and Walras, in the Leontief system although substitution is possible, it will be ruled out on economic grounds.

> "Suppose we raise wages in a Leontief system. What will happen to employment in any line of activity? An economist will be tempted to answer: If substitutability is possible, other factors (such as machinery etc.) will be substituted for labor and employment will drop. Remember, however, that everything is congealed labor in a Leontief system. Hence, when you raise wages you are also raising the cost of machines by the same proportion. Even if technical substitutability is possible, there will be no actual substitution because there will be no change in the relative prices of any factors."[1]

This arguement will of course not always apply validly to the real world. Although the fact that the coefficients are assumed to remain constant poses certain problems, these are not too serious if we are forecasting for only a few years in the future. Of course the longer the forecast that is being made the more serious will be the problem of fixed coefficients. The input-output tables that we are using to make our forecasts are tables that were prepared by the Atlantic Development Board to reflect the state of the economy in 1960. The projections are being made for 1972 and thus it is probably safe to conclude that except for the

---

[1] Dorfman, R., Samuelson, P.A., Solow, R.M. <u>Linear Programming and Economic Analysis</u> (New York: McGraw Hill Co. Inc., 1958) P. 249

manufacturing sector a radical change in the method of production has not been made. The reason that the outstanding example of the manufacturing sector has been put forward is because of the highly advanced industries which have located in Newfoundland during the past few years. Thus an attempt will be made to change the size of the coefficients in the manufacturing sector of the Newfoundland economy.

The long term forecast by input-output tables might also be thrown off by the appearance of one or more new industries during the projection period. However, this is one criticism which we can make for any type of forecast, for we are not magicians and thus cannot look into the future with complete certainty. We can of course make "educated guesses" and try to take account of new industries which are likely to come into existence, and that is really all that can or should be expected. When and if new industries do come on the horizon, the existing forecasts should be revised to take these impending changes into account.

Most of the studies done by the use of these input-output tables have encompassed static analysis, but in recent years much of the research on input-output analysis has been directed toward the development of dynamic models. As pointed out by William Miernyk,[1] while the theory of dynamic input-output analysis is in an advanced stage of development,

---

[1]Op. cit. P. 114

the statistical implementation of existing models has proceeded at a much slower rate due mostly to the scarcity of data.

In conclusion, however, in attempting analysis by using input-output tables most rational people would acknowledge that there are inherent errors in the system. The important question is whether these errors are minor enough so that we can still base quite satisfactory reliance on our outcome. We know that in the real world substitution does exist and that numerous multi-product firms do exist that do not produce only one single homogeneous product whose input structure would be changed if their "product-mix" were changed. But we also maintain at least for short term forecasting such errors, although acknowledged, can be minimized, and perhaps a better forecast can be achieved than by multiple regression analysis.

Various tests have been conducted[1] by many different people on the validity of forecasts made on the basis of input-output analysis, with several concrete conclusions

---

[1]For an excellent discussion on testing the validity of the input-output assumptions, and on tests that have been made in the U.S. and in other countries on the accuracy of projections made with input-output tables see Chenery and Clarke, op, cit. Chapter 6

being made. Tests were done by Hoffenberg in 1955 to project final demand figures for the 38 by 38 matrix, and then compare this data with what actually occured. The results obtained by this method were compared with the results using two other alternatives: projection of each industry's total output in the 1939 proportion to its own final demand, and projection of each industry's total output in the 1939 proportion to total final demand, (essentially G.N.P.). Results showed that the input-output projections were slightly better than projections with the former "final demand" technique, and a great deal better that those made by the Gross National Product technique. Yet it is interesting to note most forecasts that have been made regarding the growth of energy demand have been made by attempting to correlate the growth in energy consumption with the growth in G.N.P., with very unsatisfactory results being achieved. "Attempts then to correlate expected growth in national product with the expected rate of run-down of proven fuel reserves produced results little better than nonsense."[1] Thus the input-output method to predict future power demand is apparently a logical method to use for purposes of forecasting.

Techniques of Forecasting

There are three basic approaches to forecasting. Partial

---

[1]"Power: Forecasting American Demand," The Economist (26 October - 1 November 1968) P. 96

forecasting can be defined as the projection of one or more time series. This can easily be achieved by fitting a mathematical curve to a time series and then extrapolating. However the problem here is that there may be wide short-term variations around a trend line fitted to such a series. Another difficulty often encountered in partial forecasting is that the individual forecast may not, and in fact quite often does not add up to, a meaningful total.

Secondly, in order to avoid the problem that individual time series may pose, we can develop a model for the simultaneous projection of a group of time series by the use of simultaneous equations. Many of these models consist of systems of equations which may contain "stochastic" variables. However, although these models avoid the problem of inconsistency, the results are often affected by exogenous variables.

Thirdly, consistent forecasting has been applied to the projection of transaction tables. With consistent forecasting we can at least be sure that the projections for individual industries will add up to the total projection of the Gross National Product, or as in our case, of the Gross Provincial Product. The initial approach to take in consistent forecasting is to make a projection of the final demand for each sector that is represented in the input-output table. A new matrix can then be constructed on the basis of the assumed changes in final demand. When these individual final demands in each sector have bee projected, we add up the individual final demand columns to give a single column known as the final demand vector. We can now project a new transactions table with the new final demand figures. This process will be explained in more detail in a later section.

Even the best forecasts are usually subject to error with the probability of error being greater the further away in the future the forecast is to be made. However, it should be remembered that all forecasts perform one essentially important step in that they give us a sense of direction as to where we are heading. This allows for more efficient planning for the future. Thus forecasting should be a continuous process; if a forecast is made to-day for the next five years, but new information becomes available about what has happened, then the forecast should be revised. Thus although we know that our forecasts do not always come out exactly, we do keep them up to date.

Conventionally, the method of forecasting has been by means of multiple regression, which means that we have our given data, in this case the demand for electric power, which extends back over a number of years. This data is then assumed to give a trend on future occurences and a "line of best fit" is applied to this data and then projected forward to the future period in which the forecast is to be made. Ideally, of course, other supporting data should be available as well, such as knowledge of the rate of population increase, technological change, political considerations, and perhaps even the weather conditions, but mathematical projections have been made quite frequently by projecting forward the basis data. In any statistic book it is discussed in great detail what the best methods of projection are, and numerous curves are shown which can best suit the data which is available. The most commonly used methods are:

(1) Straight line

(2) Exponential curve

(3) Parabola

However many other more intricate equations are available by which certain data can be projected, such as the Compertz Curve and the logistic curve. However in all of these methods, although the curve may fit the data quite accurately no allowance whatsoever is made for exogenous variables that in a dynamic world are always present. If we estimate future demand for electricity on the basis of past data alone, we are not at all taking into account the whole complex of interdependant variables. For instance, when a new manufacturing enterprise is set up, especially if it is a large user of electric power, we all know that the demand for power will increase. This fact could conceivably be reflected by the conventional method of forecasting if new manufacturing had been consistently introduced in the past. However, the basic fact that a new manufacturing enterprise has been established means that more people will be employed, and these people will now spend their increased incomes on many new products. Hence demand for these new products increases, and thus this will set up a chain reaction whereby the inital increase in demand in power may be multiplied several times due to the first rise in power demand.

This phenomena has been explained by Chenery and Clarke in their book on "Interindustry Economics."

> "Interindustry analysis is needed in a range of emperical problems for which the techniques of national income analysis and of partial equilibrium analysis are inadequate. For example, an increase in demand for automobiles will have quite a different effect on specific sectors of an economy from an increase in demand for housing or for clothing, but these differences are not distinguished in an aggregate analysis. Similarly, an estimate of the future demand for electric power cannot be made very adequately from a partial-equilibrium study of the existing power market alone but must also take into account the probable changes in output of the power-using industries. In both of these examples, some kind of analysis of interindustry relations is needed."[1]

This reveals the fact that in forecasting it is often better to use the interindustry or input-output method rather than just using the conventional method of fitting a line to the given historical data and then projecting this line forward. The input-output method of forecasting was also considered better than the method quite often used in the past of correlating the expected growth in gross national product with the growth in power demand.

---

[1]Chenery, H.B. and Clark, P.G., Interindustry Economics (New York: John Wiley & Sons Inc., 1959) P. 1

Input-Output Models of Atlantic Development Board and the Modifications Necessary for Forecasting

The basic data used to predict the future demand for power are the 1960 input-output tables for the four Atlantic Provinces which were originally published early in 1968. However, it was later discovered that several inherent errors were contained in these tables, and a revised set of the 1960 input-output tables were published in September of 1968 which are the tables used in this project. Basically, two sets of tables for each of the Atlantic Provinces were complied by the Atlantic Development Board. These include a highly disaggregated 83 by 73 sector table and a more aggregated 32 by 31 sector table. In the large table the reason why a square matrix is not used is that although the intermediate set is completely symmetrical - ie. there is a corresponding column for each row - the same is not true for the final demand sectors. The intermediate sectors of course are the ones in which we are primarily interested, for it shows the interrelations which exist among the different industries. The final demand sector which is the autonomous sector in that it is the one in which changes occur and are transmitted throughout. The rest of the table contains such sectors as taxes, wages, and profit. The main difference of course between the larger table and the smaller table is that the larger table is much more disaggregated so that it contains many more individual industries. For instance, in the small table manufacturing is only broken up to include the main sectors - food, capital goods, fish products, sawmills, pulp and paper, and boat and ship building. The remaining manufacturing industries are all included in the "other" sector. However, in the larger 83 by 73 table the manufacturing sector is disaggregated into 26 different industries to include such varying manufacturing activity as cement manufacturing; meat products and poultry processors; fruit, vegetables and wineries; cordage, canvas, ribbons etc.; and railway rolling stock, truck, body, and trailer mufflers. and electric wiring. Thus, whereas in the aggregated table the manufacturing sector contains 26 different industries, in the smaller input-output table this sector is aggregated to contain only 7 sectors.

In more detail, the rows and columns in the smaller 32 by 31 table were listed as follows:

	Rows	Columns
1.	Agriculture	Agriculture
2.	Forestry	Forestry
3.	Fishery	Fishery
4.	Mining	Mining
5.	Manufacturing - Food	Manufacturing - Food
6.	Manufacturing - Capital Goods	Manufacturing - Capital Goods
7.	Manufacturing - Fish Products	Manufacturing - Fish Products
8.	Manufacturing - Sawmills	Manufacturing - Sawmills
9.	Manufacturing - Pulp & Paper	Manufacturing - Pulp & Paper

Rows	Columns
10. Manufacturing - Boat & Shipbuilding	Manufacturing - Boat & Shipbuilding
11. Manufacturing - Other	Manufacturing - Other
12. Construction - Residential	Construction - Residential
13. Construction - Other	Construction - Other
14. Transportation	Transportation
15. Utilities	Utilities
16. Services	Services
17. Intermediate Total	Intermediate Use
18. Taxes - Munipal	Personal Consumption
19. Taxes - Provincial	Investment ± Inventory
20. Taxes - Federal	Defence
21. Subsidies - Provincial	Government - Federal
22. Subsidies - Federal	Government - Provincial
23. Imports - Non Competing	Government - Municipal
24. Wages	Education
25. Unincorporated Business Income	Hospitals
26. Profit	Exports - Foreign & Rest of Canada
27. Rent and Interest	Exports - Non Regional
28. Total factor income	Imports - Non Regional
29. Depreciation	Imports - Regional
30. Household Income	Total Final Demand
31. Total Primary	Total Output
32. Total Output	

For our purpose, however, even this small table was too disaggregated. We are mostly interested in the industrial sector, in order to be able to see the industrial demand for electricity. We are also interested in the household sector of the economy, in order to be able to analyse how much increasing demand for electricity will be generated by private users of electric power. Thus in essence we took rows 1-17, and 30-32 inclusive; and columns 1-18, and 30-31 inclusive. Thus we took all of the sectors that comprise the part of the interindustry accounts, which in our case is of prime importance. We have left out the individual items that make up final demand of produced commodities and services which are broken down by major type of use, and have just taken the "total final demand" column. By means of this analysis we can show the interrelations between the different industries, and with the different industries and the household sector of the economy, to show what the ultimate final demand will be.

The tables used to predict future electricity requirements in Newfoundland are reproduced in Table 1 and 2. Table 1 shows the flow table for 1960 and table 2 shows the coefficient table for the same year. The flow tables shows the actual amounts of the transactions that took place among the different industries. Thus from the flow table we can see that the agriculture sector sold $260,000,000 worth of goods to the forestry sector, or that the transportation sector of the economy used $3,679,000,000 worth of input from

Table 5

INPUT-OUTPUT FLOWS - 1960.

	1. Agri-culture	2. Forestry	3. Fishing	4. Mining	5. Manu-facturing	6. Construc-tion
.Agriculture	1079.0	260.0	.0	.0	1782.0	13.7
.Forestry	45.0	-80.5	226.3	153.6	20773.9	122.4
.Fishing	.0	.0	.0	.0	12478.4	.0
.Mining	.0	.0	700.0	.0	420.7	1282.0
.Manufacturing	905.0	229.3	2103.5	1495.6	13536.6	29430.6
.Construction	367.0	294.0	164.0	912.0	1246.2	28.0
.Transportation	204.2	361.6	546.0	15209.9	5295.5	15037.3
.Electric Power	100.0	4.7	.0	391.9	3084.4	272.1
.Gas & Water Systems Radio Broadcasting Telephone & Telegraph	40.0	270.7	79.1	333.0	513.9	387.2
.Services	588.1	1444.3	766.7	5977.6	6429.1	20492.3
.Intermediate Total	3328.7	2734.3	4615.6	24973.7	64860.6	67063.6
.Household Income	2777.2	22555.9	[illegible]	22356.0	41362.1	51300.4
.Final Demand	3632.3	29329.2	[illegible]	58584.1	70271.6	76274.5
.Total Output	5961.0	32113.5	21535.7	83558.1	135136.3	143340.1

	7. Transporta-tion	8. Electric Power	9. Gas & Water Systems Radio Broadcasting Telephone & Telegraph	10. Services	11. Intermed-iate	12. Personal Consumption	13. Final Demand	14. Total Output
.Agriculture	.0	.0	.0	2.5	2437.2	10870.2	4523.8	6961.0
.Forestry	.0	.0	.0	.0	21240.9	2449.2	10872.5	32113.5
.Fishing	.0	.0	.0	.0	12478.4	.0	9057.3	21535.7
.Mining	2.5	.0	.0	.0	2406.2	.0	81151.0	83558.1
.Manufacturing	3679.0	32.6	82.3	4198.3	55693.2	90761.3	79439.5	135136.3
.Construction	734.4	551.0	455.0	11014.0	15815.6	.0	127524.4	143340.1
.Transportation	1983.6	113.6	193.2	11190.7	49955.5	30806.4	30665.6	80710.9
.Electric Power	481.8	.0	92.0	589.4	5916.3	3781.1	5007.7	10924.0
.Gas & Water Systems Radio Broadcasting Telephone & Telegraph	647.1	2.5	[illegible]	2748.5	5307.7	2655.1	3733.3	9041.0
.Services	15613.1	259.7	462.3	16992.0	63836.1	142999.6	151075.6	214983.0
.Intermediate Total	15993.5	980.4	1490.2	47335.7	235117.3	284322.9	503219.3	738303.5
.Household Income	45281.1	1260.0	4370.3	101146.4	309373.7	.0	206.5	309584.4
.Final Demand	62619.3	9383.6	[illegible]	167947.2	503651.0	97893.7	[illegible]	667873.5
.Total Output	80710.8	10924.0	9041.0	214983.0	738303.5	382206.6	667873.9	1[illegible]5377.2

Table 6

INPUT-OUTPUT COEFFICIENTS - 1960

	1. Agri-culture	2. Forestry	3. Fishing	4. Mining	5. Manu-facturing	6. Construc-tion	7. Transporta-tion	8. Electric Power	9. Gas & Water Systems Radio Broadcasting Telephone & Telegraph	10. Services	11. Intermed-iate	12. Personal Consumption	13. Final Demand	14. Total Output
Agriculture	.1550	.0081	.0000	.0000	.0080	.0001	.0000	.0000	.0000	.0000	.0033	.0248	.0068	.0050
Forestry	.0065	-.0025	.0105	.0018	.1537	.0085	.0000	.0000	.0000	.0000	.0288	.0064	.0163	.0229
Fishing	.0000	.0000	.0000	.0000	.0923	.0000	.0000	.0000	.0000	.0000	.0169	.0000	.0136	.0153
Mining	.0000	.0000	.0325	.0000	.0031	.0089	.0001	.0000	.0000	.0000	.0033	.0000	.1217	.0595
Manufacturing	.1300	.0071	.0977	.0179	.1002	.2053	.4550	.0030	.0091	.0195	.0754	.2735	.1191	.0962
Construction	.0527	.0092	.0076	.0109	.0092	.0002	.0097	.0504	.0503	.0512	.0214	.0000	.1912	.1020
Transportation	.0293	.0113	.0254	.1820	.0392	.1049	.0246	.0104	.0114	.0521	.0677	.0806	.0460	.0574
Electric Power	.0144	.0001	.0000	.0107	.0228	.0019	.0060	.0000	.0102	.0046	.0080	.0099	.0075	.0078
Gas & Water Systems Radio Broadcasting Telephone & Telegraph	.0057	.0084	.0032	.0040	.0038	.0027	.0080	.0002	.0316	.0128	.0072	.0069	.0056	.0064
Services	.0845	.0450	.0365	.0715	.0476	.1430	.1303	.0257	.0445	.0790	.0865	.3741	.2265	.1530
Intermediate Total	.4782	.0867	.2139	.2989	.4800	.4678	.2242	.0897	.1570	.2193	.3184	.7439	.7544	.5253
Household Income	.3990	.7117	.6948	.2676	.3098	.3559	.5610	.2069	.5387	.4705	.4140	.0000	.0002	.2203
Final Demand	.5215	.9133	.7861	.7011	.5200	.5321	.7758	.9103	.8428	.7807	.6814	.2561	.[illegible]59	.4752
Total Output	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

the manufacturing sector. The coefficient table, on the other hand, shows the amount of input (in dollar terms) required by an industry to produce a dollar's worth of output. Thus, we can see for instance that the mining industry uses $.0018 from the forestry industry in order to produce $1.00 worth of output. If we look at the intermediate total row we see that the mining industry uses $.2989 worth of input from all of the other industries combined. The remaining inputs come from the final demand or total primary sector which of course includes the household income row. We can see from table 2 that household income comprised the major portion of the inputs for most industries. Household income includes such items as wages, salaries, dividends, etc. paid out. Thus it is shown in table 2 that the mining industry used $.2676 input of household income to produce $1.00 worth of output; ie. it paid our in wages, salaries, dividends etc. 26.76¢ per dollars worth of output. The intermediate row and the final demand row coefficients should add up to 1.0000 in the total output row. However this may not always be the case due to rounding.

As already mentioned, for our purposes even the 32 by 31 smaller table published by the Atlantic Development Board is too disaggregated. The reason for this is that when forecasting for the future by means of the input-output table the final demand for each industry has to be projected seperately, and only when this has been done can we project a new transactions table. Thus the reason for aggregation is the dearth of available data by which to make the individual projections. In order to facilitate, and indeed make possible, individual output forecasts, certain compromises had to be made. The agriculture, forestry, fishery, and mining industries were kept unchanged from the original A.D.B. tables. However, in the original tables the manufacturing sector was disaggregated into the "food," "capital goods," "fish products," "sawmilling," "pulp and paper," boat and shipbuilding," and "other" industries. Because sufficient data simply is not available to make individual projections for these industries, they were all aggregated under the title "Manufacturing."

The construction industry in the original publication was disaggregated to include construction residential and construction-other. Again, due to a lack of data for projection purposes this sector had to be aggregated under "construction."

The transportation sector remained the same as it was in the original table.

In the original table there was one sector entitled "utilities." Since this of course contains the electric power industry in which our primary concern lies, every effort had to be made to disaggregate this sector. Upon closed examination and comparison it was seen that in the larger 83 by 73 table utilities were disaggregated to include radio broadcasting; telephone & telegraph; electric power; and gas and water systems. For our purposes we eliminated electric power in a single sector, and then added together gas and water systems plus radio broadcasting, telephone & telegraph in another sector.

The services sector, intermediate total, household income, final demand, and total output sectors were kept as in the original table.

Final Demand and Value Added

In order to predict future demand by means of the input-output table we first of all have to predict final demand in each sector of the economy that we have listed in our input-output table. The method we have used is rather indirect. We predicted the value added, and then took the ratio of final demand to value added for each sector in 1960, and assumed that the same ratio would apply in 1972. In order to predict total final demand it would have been much better and more accurate to predict each component of the final demand, and added them up in order to ascertain the total final demand for 1972. In the smaller 32 by 31 input-output tables for 1960 the final demand column comprises of:

1) Personal Consumption
2) Investment
3) Defence
4) Government, Federal
5) Government, Provincial

6) Government, Municipal

7) Education

8) Hospitals

9) Exports - Foreign and Rest of Canada

10) Exports, Regional

11) Imports, Non Regional

12) Imports, Regional

Ideally we should calculate the 1972 sales into each component of final demand by each of the sectors of the economy, add them up, and thus reach our predicted final demand. Thus, we should ascertain how much consumers will spend on agriculture, how much the federal government, provincial government, and municipal government will spend on agriculture; how much will be imported, exported and so on, until we get the total final demand for agriculture. We then proceed in the same way with the forestry, fishing, mining etc. industries. This could be done by projecting into the future historical data which had been collected, and adjusting for any discrepancies. However, due to a lack of data this could not be done. We could perhaps fairly reasonably estimate federal government or provincial government expenditure on the various items, but the most important segment of final demand, such as consumption expenditures, and even more important imports and exports cannot be determined, for no statistics are available at the present time to show how much the consumer in Newfoundland spends on for instance transportation, or agricultural products; nor do we know what the exports or imports are at the present time. Since records for such transactions are only kept on a national scale and not on a regional basis, we had to proceed by a slightly more circuitous route, and one a little bit more bumpy, but nevertheless we arrived safely. The method of projecting the value added to 1972 and then estimating the final demand in the method already explained is the only method available that can be used.

Linear Homogeneous Consumption Function

We also assumed a linear homogeneous consumption function when we included the household sector of the economy in the internal structure of the input-output table. Due to lack of statistical data on the consumption pattern of the Newfoundland householder we could not make any valid estimates on how our consumer would spend his marginal dollar. It is of course obvious that in compliance with Engels Law proportionately less of the increased income would be spent on food and proportionately more on some other items such as automobiles; but due to lack of consumer surveys these could not be quantified and it was felt that it would be better to assume the linear homogeneous consumption function.

Chapter 4

DEMAND PROJECTIONS OF ELECTRIC POWER

Future power requirements have been forecasted by first calculating the final demand in each industry. This was done by obtaining the historical value added[1] figures from 1955 to 1965 for agriculture, forestry, fisheries, mining, electric power, manufacturing, and construction industries, and then estimating final demand from value added.

The method used to obtain the value added for the remaining industries was to calculate the gross provincial product for Newfoundland and then substract the given forecasted figures in order to arrive at the 1972 value added for these industries, ie. services plus gas and water systems, radio broadcasting, telephone and telegraph.

Household income had to be estimated in a rather

---

[1]Except for agriculture, the value added figures for all the industries were obtained from figures published by the Dominion Bureau of Statistics, Survey of Production 1964-1965, Catalogue No. 61-202. D.B.S. does not publish the figures for agriculture in Newfoundland due to the relative insignificance of the agriculture sector in this province. The figures for agriculture were obtained from the report of the Royal Commission of the Economic State and Prospects of Newfoundland and Labrador, op. cit. P. 83. Although the forecast here is for 1971, and we are interested in the year 1972, it is a relatively simple matter to adjust the figures upward, simce no radical change can be seen in the agriculture sector of the Newfoundland economy.

circuitous manner, due to the non-existance of data on household income. Under the label "household income" are included among other items wages, salaries, dividends, interest and similar payments made to households by each of the industries and other sectors listed across the top of the table. However, wages, salaries and supplementary labor income which are published by the Dominion Bureau of Statistics each year comprise the major portion of the household income sector. For instance, in 1960 the wages, salaries, and supplementary labor income as reported by D.B.S. was $260 million, whereas the total household income as reported in the input-output tables was only $310 million. Thus 84 per cent of household income was made up of wages, salaries and supplementary labor income. Since actual household income data are not available it was decided to plot the actual wages, salaries and supplementary labor income[1] (graph 1) in constant 1960 dollars. An exponential growth curve was then fitted to the data which was deflated to 1960 dollars. The slope of this line was then applied to the 1960 household income as given in the input-output table, and this was then used to predict the household income for 1972. The slope of the exponential curve revealed that wages, salaries and supplementary labor income increased at an annual rate of 8.17 per cent. If we apply this data to the

---

[1]Canada, Dominion Bureau of Statistics, National Accounts, Income and Expenditure, Catalogue No. 13-201, 1955-67

household income for 1960 of $310 million we see that the predicted household income for 1972 should be $645 million in 1960 dollars.

The value added for the forestry, fishery, mining, manufacturing, construction and electric power industries were obtained from data published by D.B.S.[1] Since this data is in current dollars it was deflated to 1960 dollars. Value added for the service industries are not published[2] and thus had to be estimated by obtaining the predicted Gross Provincial Product and subtracting the predicted value added for the remaining industries.

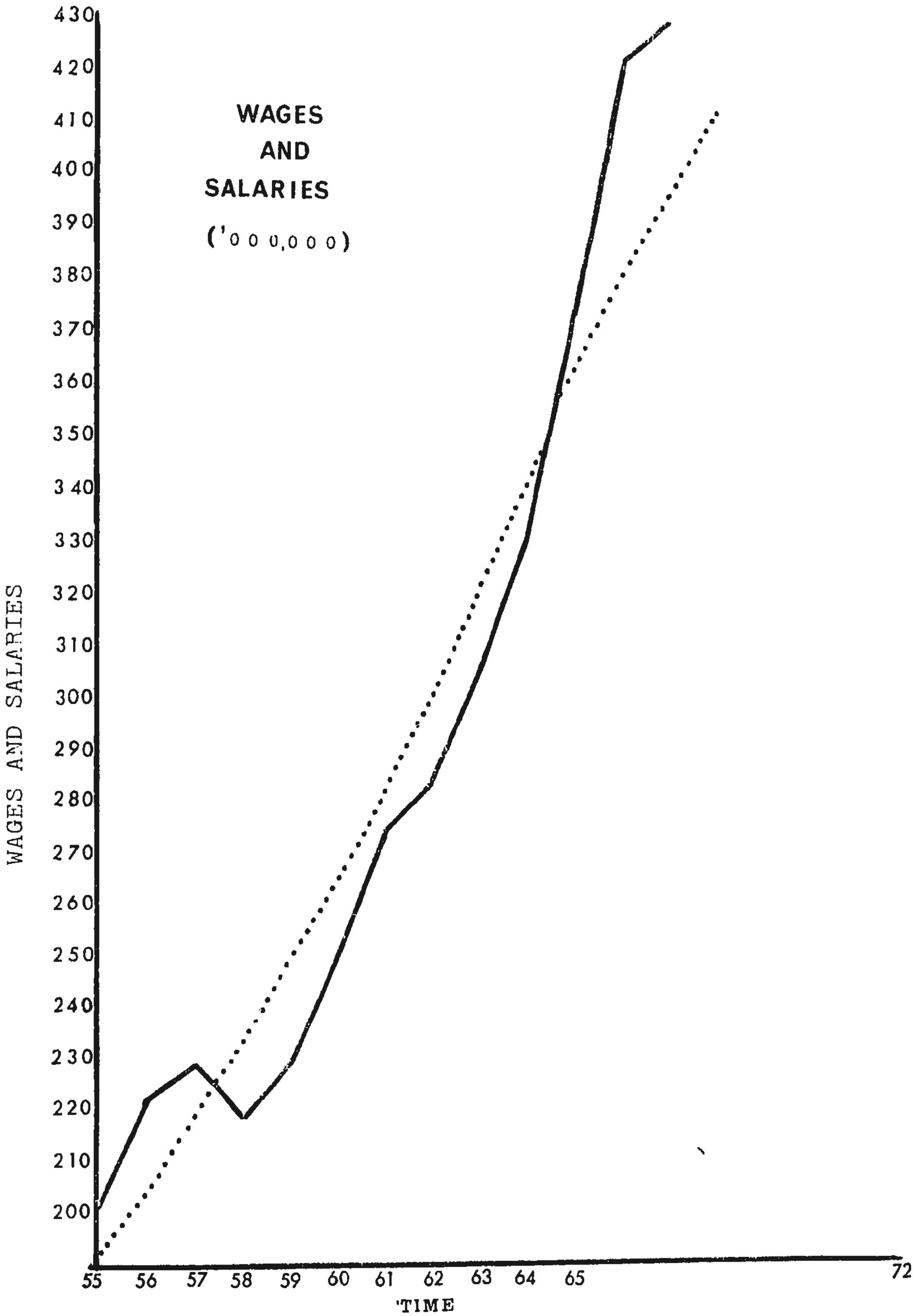
The actual value added (in 1960 dollars) are plotted on graphs 2-7. An exponential growth curve was then fitted to the data and extrapolated, to give the forecasted 1972 value added. The same procedure was used to predict the 1972 gross provincial product. Graph 8 shows the actual gross

---

[1]Canada Dominion Bureau of Statistics, Survey of Productions, 1964-64, Catalogue No. 61-202, P. 11, P. 21, P.22, P.24, P.25, P. 26, P.27.

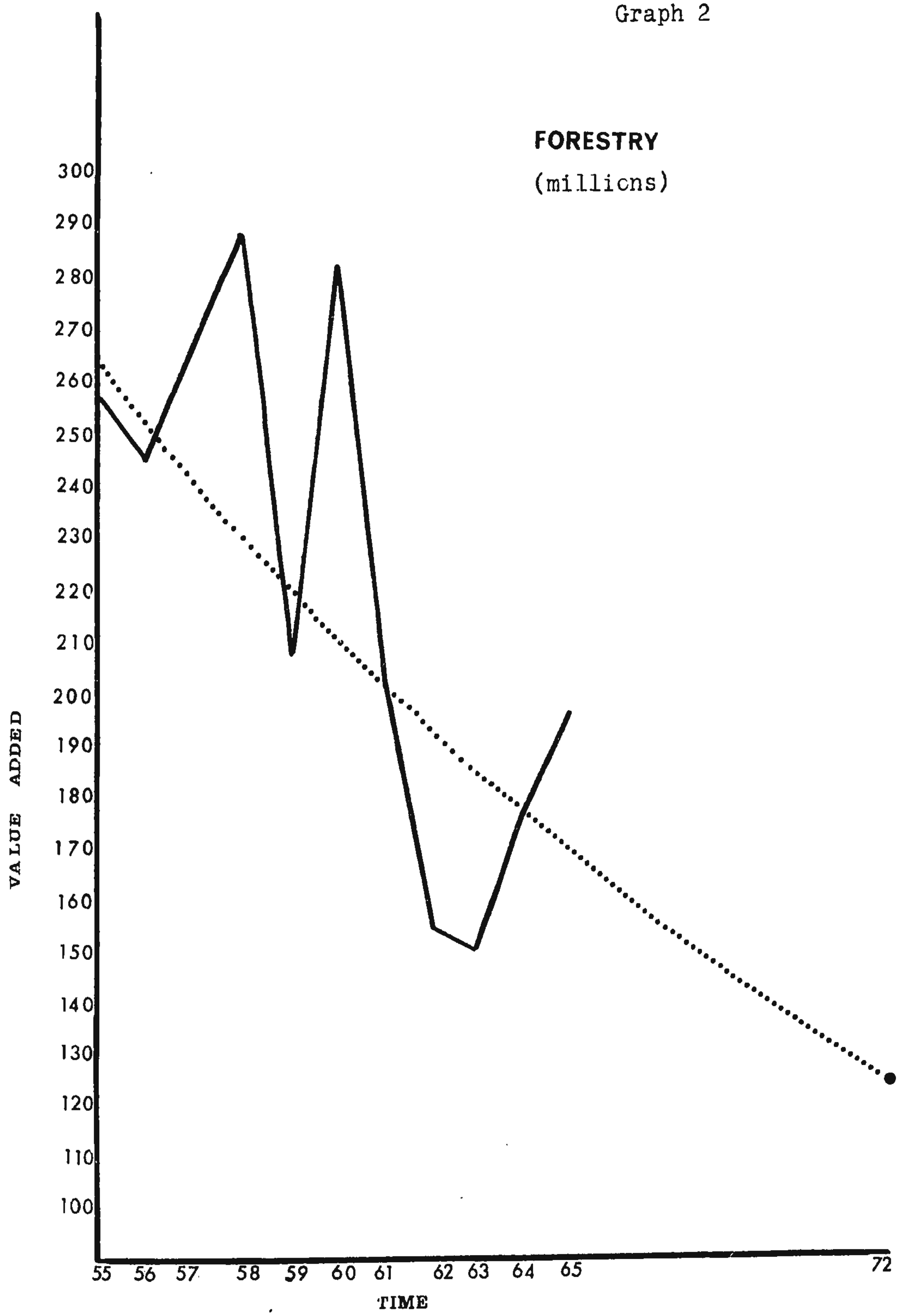
[2]"At the present time this report is limited in scope to those industries primarily engaged in the productions of commodities. Thus the output of the service-producing industries (transportation, storage, communication, wholesale and retail trade, finance, insurance, real estate, public administration and defence, personal service, business service, community service and recreation service,) is omitted except insofar as the cost of some of these services remains in the censes value added of the commodity-producing industries." Ibid. P. 6

Graph 1



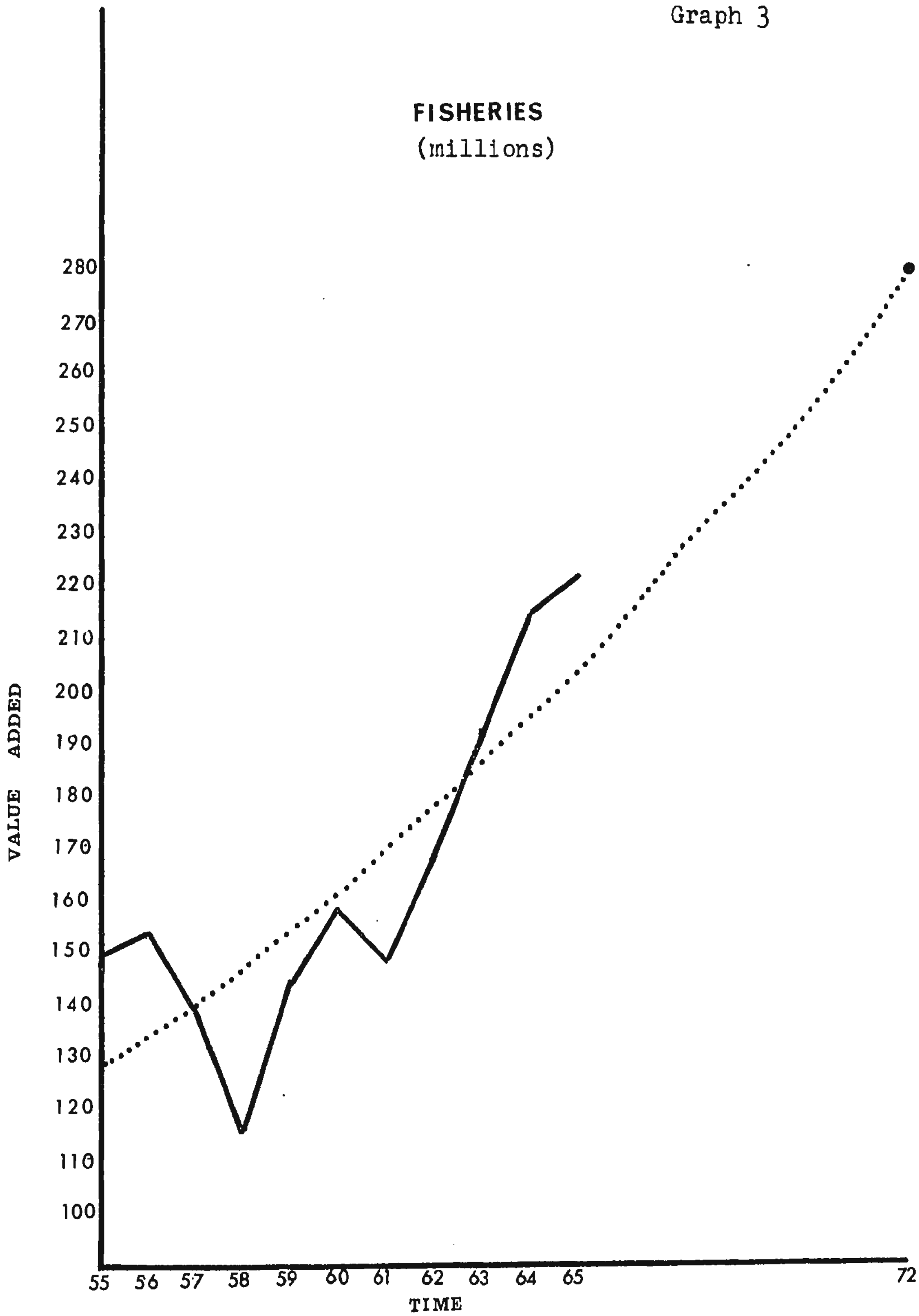
Actual value added 1955-65 and the logarithmic trend in value added 1955-72, $y=ab^x$; $y=(291.0)(1.663)^x$
y=wages and salaries, x=time coded in years, a=constant value added at midpoint between 1955, and 1965,
b=annual growth rate.

Graph 2



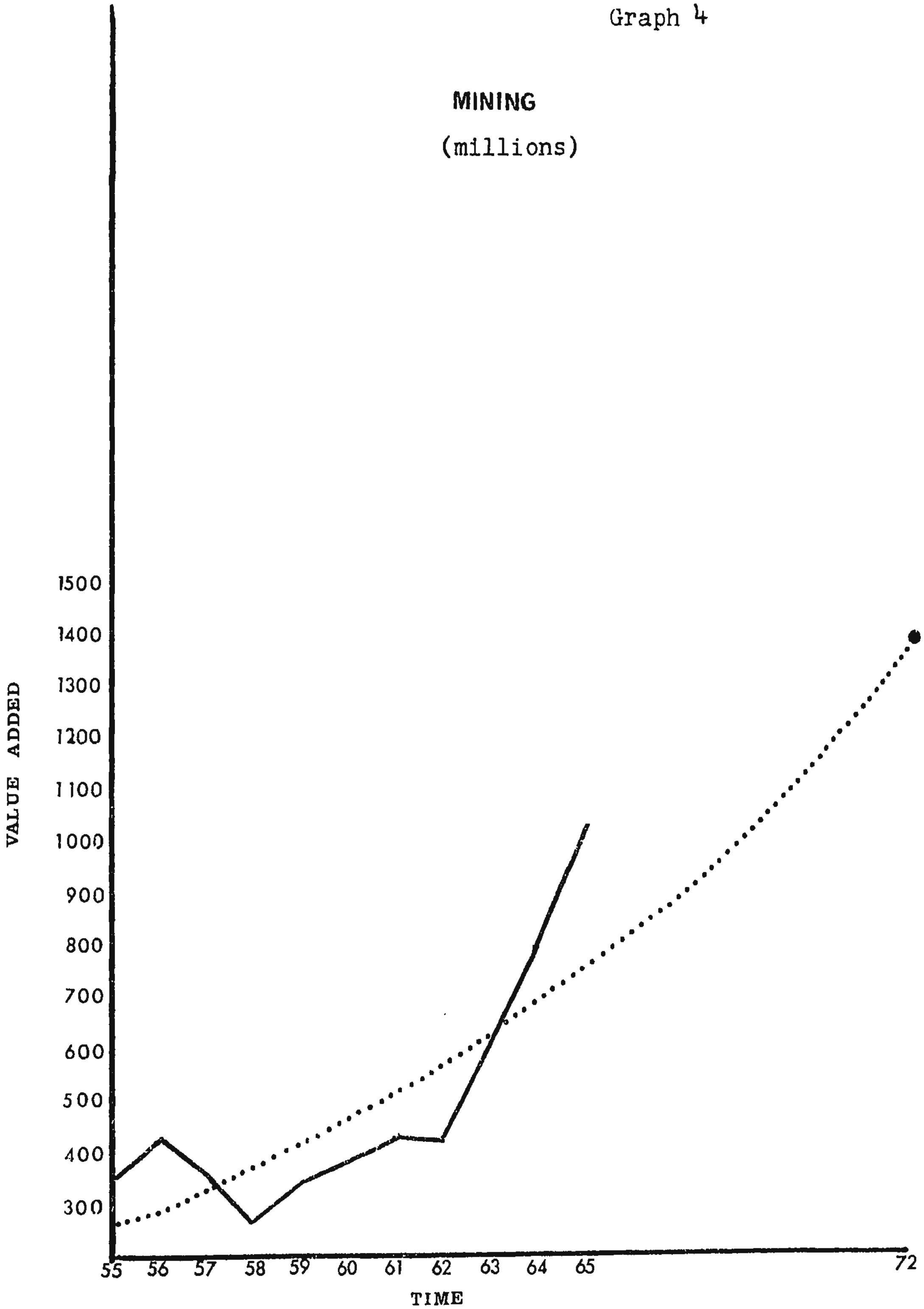
Actual value 1955-65 and the logarithmic trend in value added 1955-72, $y=ab^x$; $y=(21.140)(1.046)^x$
y=forestry value added; x=time coded in years;
a=constant value added at midpoint between 1955, and 1965,
b=annual growth rate.

Graph 3



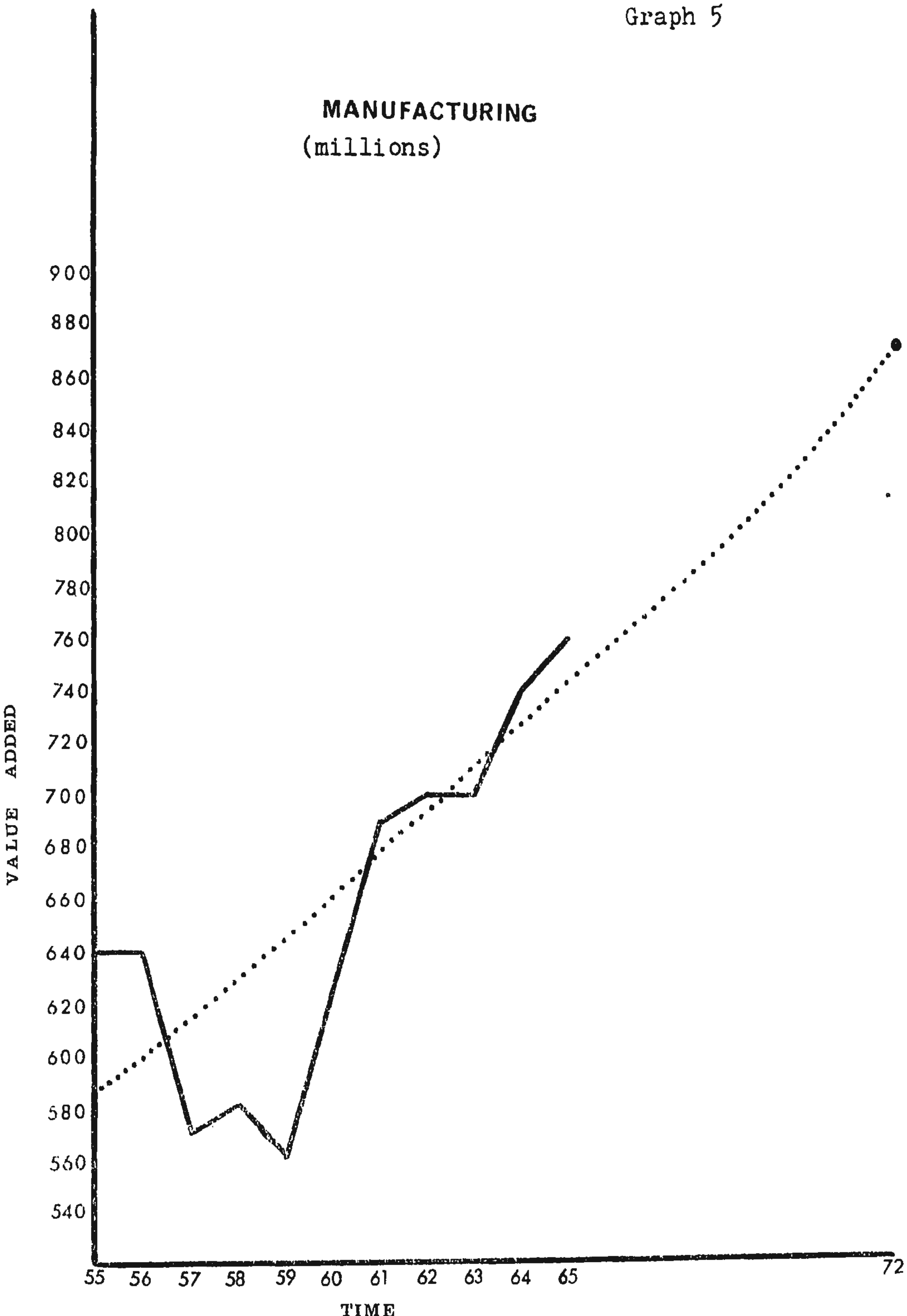
Actual value 1955-65 and the logarithmic trend in value added 1955-72, $y=ab^x$; $y=(16.140)(1.047)^x$
y=fisheries value added; x=time coded in years;
a=constant value added at midpoint between 1955, and 1965,
b=annual growth rate.

Graph 4



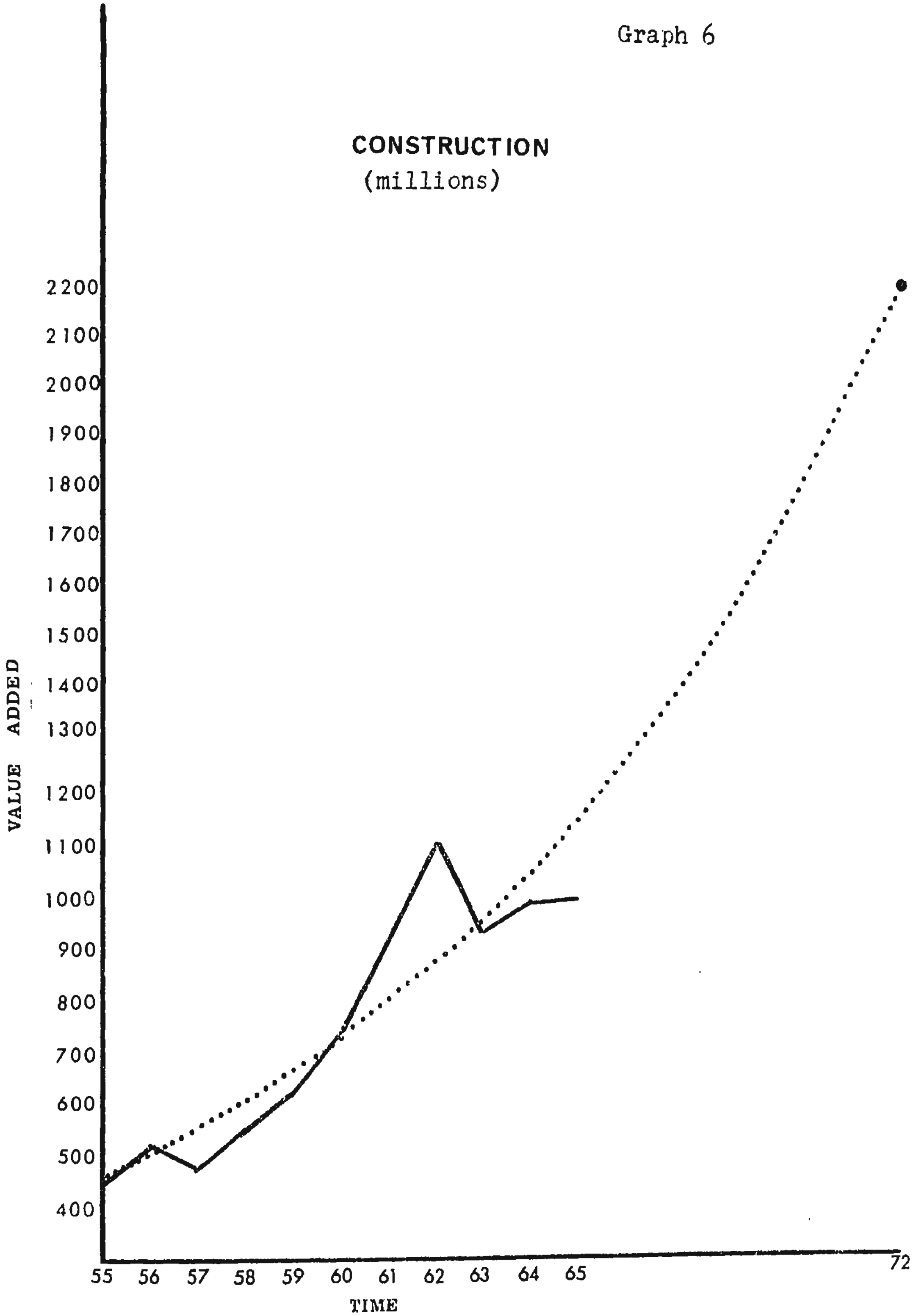
Actual value 1955-65 and the logarithmic trend in value added 1955-72, $y=ab^x$; $y=(56.72)(1.084)^x$
y=mining value added; x=time coded in years;
a=constant value added at midpoint between 1955, and 1965,
b=annual growth rate.

Graph 5

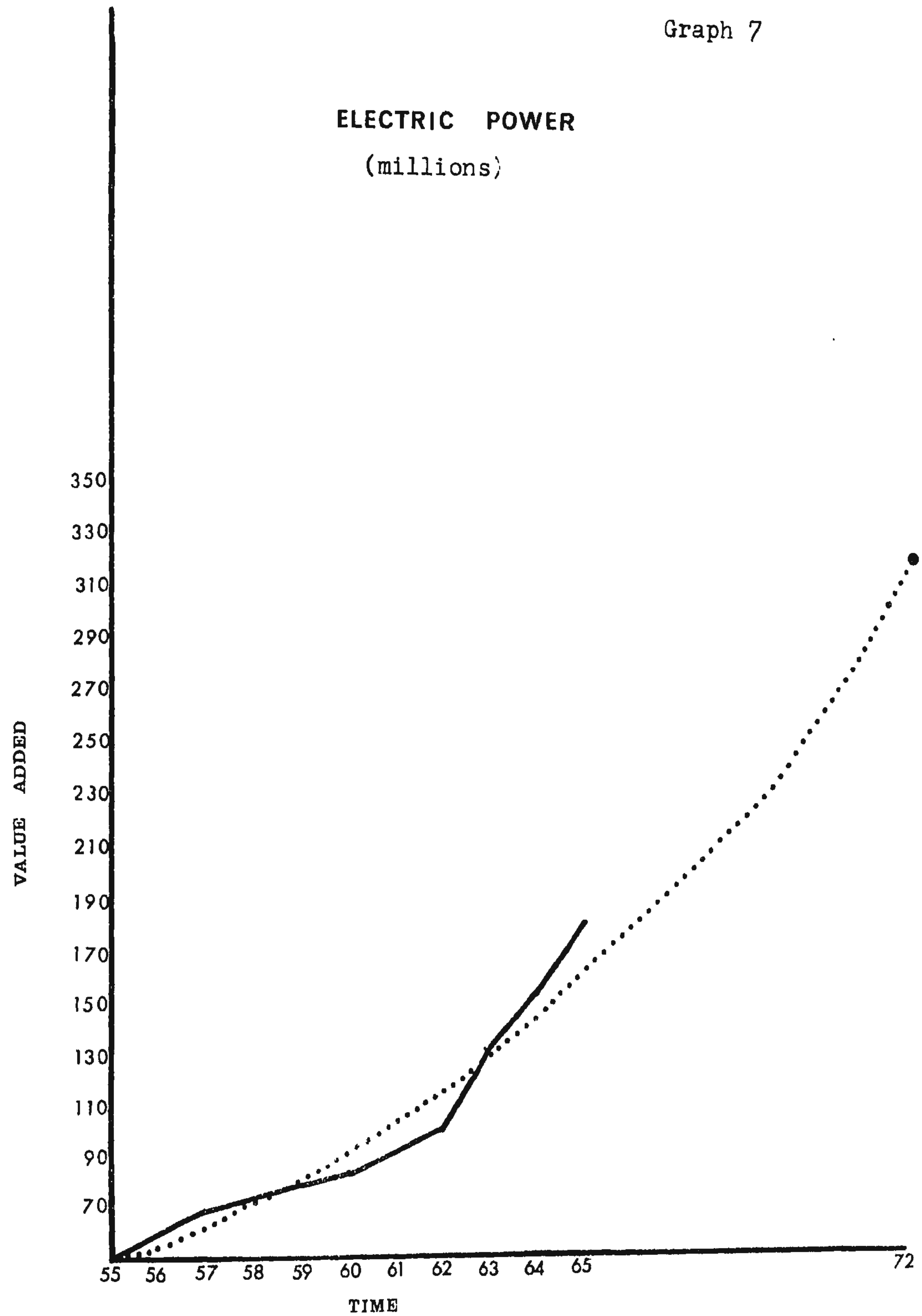


Actual value 1955-65 and the logarithmic trend in value added 1955-72, $y=ab^x$; $y=(65.4)(1.024)^x$
y=manufacturing value added; x=time coded in years;
a=constant value added at midpoint between 1955, and 1965
b=annual growth rate.

Graph 6

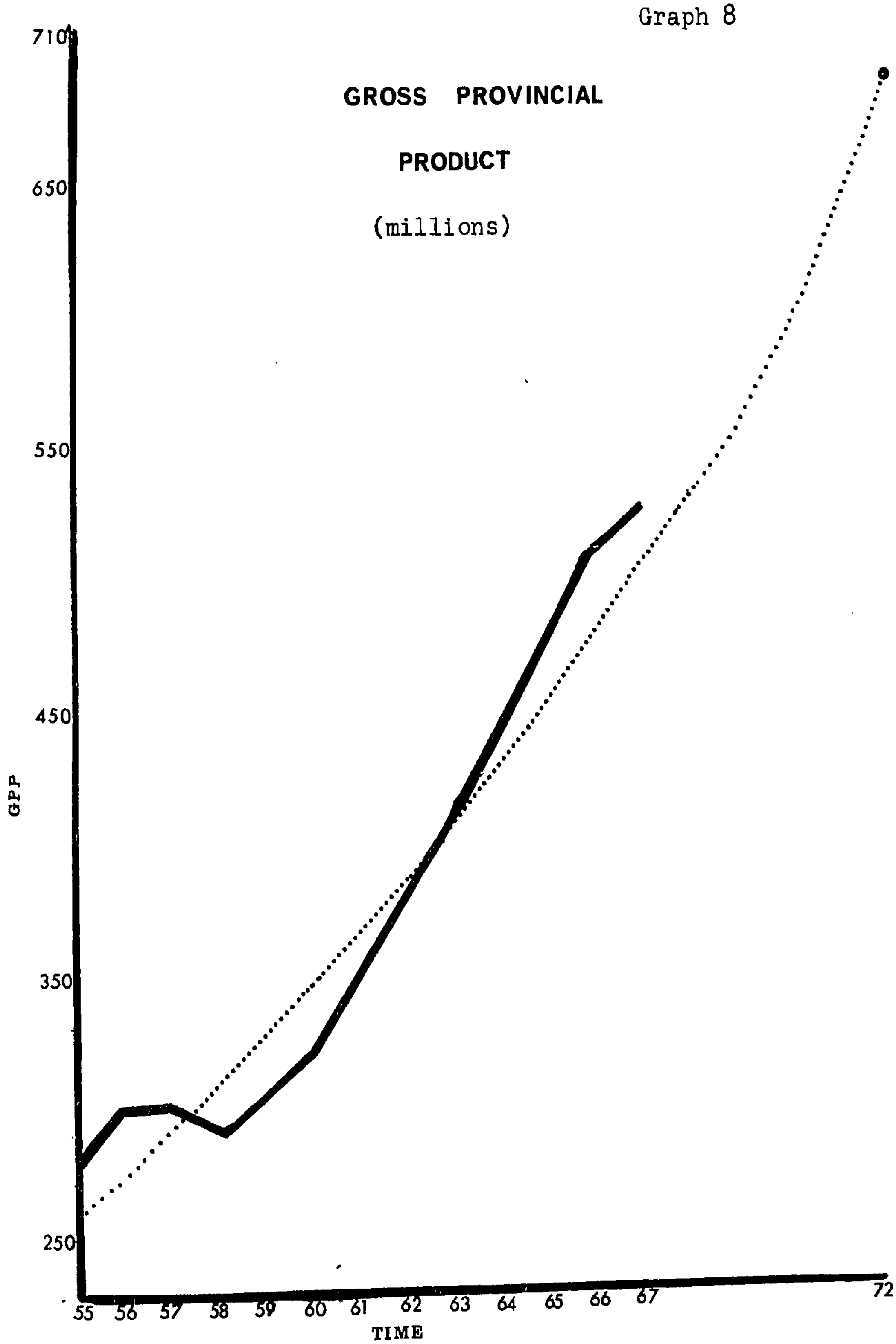


Actual value 1955-65 and the logarithmic trend in value added 1955-72, $y=ab^x$; $y=(71.56)(1.097)^x$
y=construction value added; x=time coded in years;
a=constant value added at midpoint between 1955, and 1965,
b=annual growth rate.



Actual value 1955-65 and the logarithmic trend in value added 1955-72, $y=ab^x$; $y=(110.5)(1.097)^x$
y=electric power value added; x=time coded in years;
a=constant value added at midpoint between 1955, and 1965,
b= annual growth rate.

Graph 8



Actual value 1955-65 and the logarithmic trend in value added 1955-72, $y=ab^x$; $y=(369.0)(1.059)^x$ y=gross provincial product value added; x=time coded in years; a=constant value added at midpoint between 1955, and 1965, b=annual growth rate.

provincial product estimates as prepared by the Newfoundland Department of Finance, Economics and Statistics Division. The current G.P.P. was deflated by the implicit price index[1] in order to express it in terms which are independent of changes in the general level of prices.

Graph 2 shows the historical trend value added in the forestry industry from 1955 to 1965, and the projection of trend value added to 1972 by means of the exponential curve. Historically the value added in the forestry industry has fluctuated quite radically, so that an accurate forecast is almost impossible to achieve. The 1972 projected value added is quite low and thus probably not too accurate. However, the predicted forestry value added has been increased due to the fact that the new linerboard and papermill industries will employ large amounts of forestry products.

The value added for the fishery industry (graph 3) is much easies to predict, since this industry has increased at a much more steady rate, and the "fit" of the exponential curve to the actual data is much better. Since the fishery industry is not predicted to increase or decrease operations radically in the future, we do not need to update the value from the historical projection.

Mining activity (graph 4) from 1962 to 1965 has increased

---

[1]Canada Dominion Bureau of Statistics, National Accounts, Income and Expenditure, Op. Cit. 1955-67.

quite rapidly, in contrast to the quite lethargic performance between 1955 and 1961. This was due to the start of new mines in Labrador. However, because of the closing of other mines such as the iron ore mine on Bell Island and the fact that at the present time there are not any radical new developments foreseen, the value added for 1972 as obtained by fitting the exponential curve to the historic data should be quite accurate.

Since 1959 manufacturing activity (graph 5) has increased at a quite steady pace, although a setback was experienced between 1962 and 1963. Due to the predicted establishment of several new industries by 1972 we have increased the forecasted 1972 value added quite considerable.

The construction sector of the economy (graph 6) grew quite rapidly from 1957 to 1962, but since then it has experienced some difficulties, and the growth rate has declined considerably.

Value added in the electric power industry has increased at a steady pace since 1955 (graph 7) so that the value added for 1972 based on the exponential growth curve should reflect the 1972 forecasted value added.

The Gross Provincial Product (graph 8) has also increased at a quite rapid rate since 1958. Only from 1955 to 1958 did the actual G.P.P. show any decline.

The actual value added estimates which were compiled for 1972 are given in Table 7:

Table 7

Projected Value Added For 1972

(Millions)

Agriculture	$ 5
Forestry	12
Fisheries	28
Mining	148
Electric Power	34
Manufacturing	87
Construction	217
Services	75
Gas, Water Systems, Telephone & Telegraph	5
Transportation	28
	$639
Household Income	$310
Gross Provincial Product	$639

However, one cannot depend on the historical trend values. Additional information is required to give a more accurate forecast, for the future often cannot be forecast on past performance alone. For instance, for the manufacturing sector we have projected the value added of $87 million for 1972. However, this will have to be revised due to the fact that the manufacturing sector of the

Newfoundland economy has increased quite substantially in the past few years. This fact would not be revealed by extrapolation of past data alone.

Thus to account for the fact that large new industrial plants such as the Petroleum Refinery, Anhydrous Ammonia Plant, and Paper Mill in Come by Chance; the Aluminum cable plant and Linerboard mill in Stephenville; and the Phosphorous plant in Long Harbour (all of which are large users of electric power) either have or will soon come into production, revised estimates of the net value of production will have to be made.

We have thus compiled new value added estimates to comply with our assumption that the structure of the economy will undergo some quite radical changes in the next few years. This assumption is validated by the fact that many new manufacturing industries which will consume large amounts of power will come into production in the near future; some already are in production, others will be in production by 1972. In more detail, the manufacturing plants which are being established and should be taken into account are:

Aluminum Cable Plant in Stephenville
Petroleum Refinery in Come by Chance
Anhydrous Ammonia Plant in Come by Chance
Newsprint Mill in Come by Chance
Linerboard Plant in Stephenville
Fish Processing Plants in several settlements
Phosphorous plant in Long Harbour

Magnesium Hydroxide Plant in Aguathuna

Due to these new industries the demand for electricity will increase quite substantially, as several (such as the phosphorous plant which will require about 750,000,000 kilowatt-hours of electricity to produce an output of 60,000 tons of phosphorous) are quite large users of electric power. The manufacturing sector is thus the main sector of the economy which we have to watch, since it is from this sector where a large amount of the increased demand for power will originate.

The agriculture sector of the economy in Newfoundland is so minute that no statistics on value added are given by D.B.S. Thus we have kept the forecasted $5 million value added as given by the Royal Commission on the Economic State and Prospects of Newfoundland and Labrador.

The future value added for Forestry based on historical data is $12 million as shown in Table 7. However, as can be seen from graph 2 the value added in the forestry industry has fluctuated quite spasmodically in the past. Because of this our forecast of $12 million is substantially below even the 1965 value added for which data is available. However, with the addition of the newsprint mill at Come by Chance, and the Linerboard plant in Stephenville, it is apparant that the forestry value added should be much more than $12 million. Thus we have estimated that an extra $22 million should be added to take account of expected new production in forestry to give a total value added of $34 million.

No new developments are estimated in the fishing industry, so we have basically taken the forecasted value added based on historical data. However, due to the emergence of several new fish processing plants we have increased this estimate slightly.

For mining our 1972 forecasted value added is the same as the one based on historical data, since no new radical developments are expected to take place. Although new developments in the mining industry have occured in Labrador, this can probable be offset by the closing of the Bell Island iron ore mine, so that our historical projections should be fairly accurate. Of course, any such estimate should be revised if and when new information becomes available, such as more definite information on whether any mining will take place in the proposed silica quartz mine in Bonne Bay. The main difficulty in forecasting future requirements for any natural resource development such as mining is that we never know when and where a new discovery may be made.

The construction sector of the economy is always one of the most volatile, and hence terribly difficult to predict accurately. We know that due to these new manufacturing firms which will be built, new construction activity will occur. However, due to higher interest rates for mortgages and actually a general rise in all interest rates, construction activity may decline. To show how volatile the activity in the construction industry is, between 1964 and 1965 the value added increased by only 1.6 per cent in current dollars while from 1965 to 1966 it increased by 48.3 per cent. We have estimated that the value added in 1972 should be the same as that projected on historical basis.

The value added for the service; gas and water systems, telephone and telepraph; and transportation industries were obtained by estimating the gross provincial product and subtracting the total of the value added already obtained, (by adding up the value added of the available industries) in order to obtain the difference, and hence distribute the value added for these industries in approximately the same ratio as in 1960.

The following table shows our adjusted value added for the various industries in 1972. The gross provincial product has been adjusted upward quite considerably. The reason for this is that the gross provincial product is predicted to grow at a much faster rate in the future than in the past, due to addition of the new manufacturing establishment. It is important to realize that at present all the manufacturing plants mentioned previously are supposed to be in production by 1972. However, as is the case quite often, delays may occur, and in that case the gross provincial product will not grow as fast, and hence electricity consumption will not grow at such a rapid rate.

In table 8 the predicted household income for 1972 is given as well. The reason for this is that when we begin to calculate the demand that will be created for electric power we will consider the demand that will be created in two ways:

1) the demand created by industries alone.
2) the total demand created when we also take household demand into account.

Table 8

Adjusted Value Added 1972 (Millions)

Industry	Value Added
Agriculture	$ 5
Forestry	34
Fishing	33
Mining	134
Manufacturing	212
Construction	217
Transportation	90
Electric Power	41
Gas and Water Systems Radio Broadcasting Telephone & Telegraph	12
Services	227
GPP or Total Value Added	1005
Household Income	$ 645

The demand created by private consumers should increase quite considerably in the future. For instance manufacturer's of major appliances, beset in recent years by unsatisfactory profit levels and a tardy rate of sales growth estimate that market demand increased by 6 per cent in 1968. This resulted due to an increase in housing completions, relatively high employment and earnings, and improved consumer confidence. Another factor was the relatively stable price of most appliances, as compared with other items. Taking the retail price index as 100 in 1956, the latest ratings according to D.B.S. are:[1]

Refrigerators	71.3
Stoves	83.3
Freezers	67.2
Automatic Washers	75.0
Automatic Dryers	95.0

This compares with such items as 120.9 for automobiles, 129.9 for men's clothing, 136.8 for meat products, and 118.9 for furniture.

Although these price indexes are for Canada as a whole, the general trend of more electricity consumption by households due to the fact that more electrical appliances will be bought holds true for Newfoundland as well. More

---

[1]Globe and Mail, Jan. 10, 1969.

households will also use electric heating in the future, which also will increase the demand for electric power. However, the demand that will be created by the household sector of the economy will only be a small fraction of what will be created by the new industries.

<u>Demand Projections by Input-Output Techniques</u>

The projected value added for 1972 are given in table 8. Turning now to our input-output tables in chapter 3 (table 5) we see that row 13 which is labeled "Final Demand" shows the actual value added figures for 1960. Thus for 1960 value added in Forestry was $29,329,200. By adding up the individual items in row 13 we are able to get the gross provincial product which is shown in the intersection of row 13 and column 11. This same figure (the gross provincial product) appears in the intersection of row 11 and column 13. The difference between row 13 and column 13 is that row 13 shows the composition of gross provincial product on the expenditure side, and column 13 shows the composition of gross provincial product on the income side. In order to perform the necessary calculations, the final demand as given in column 13 is required. However, since we only have available the value added as given in row 13 the method used was to find the percentage that each figure in column 13 was of the corresponding figure in row 13 in 1960, and hence apportion the 1972 final demand by the same proportion.

Once our final demand for each sector of the economy that we have represented in our input-output table has been calculated, it is a relatively simple task to predict the total output (or demand) created for the electric power industry. It is simple a matter of multiplication. As previously mentioned, we have done this in two ways:

1) Not including household demand.

2) Including household demand.

Using method 1 we can see the demand that will be created for electric power by the industrial sector of the economy, by tracing the demands that will be made on the electric power industry by all the other economic activity in the area by means of an input-output table with appropriate regional coefficients. Basically we are employing the same coefficients as in table 6 with one notable exception: we have changed the coefficients in the manufacturing column. This has been done due to the fact that it is quite noticable that the technology in the manufacturing sector will change due to the introduction of these new manufacturing industries, and hence what we have done is to change the coefficients in the manufacturing column in accordance with anticipated changes in the total output of the manufacturing sector, and the inputs from other sectors of the Newfoundland economy, (ignoring imports from outside of the province) that will be required to support this increased output, (See Appendix 5). In calculating the new

Table 9

INPUT-OUTPUT COEFFICIENTS - 1960

	1. Agri-culture	2. Forestry	3. Fishing	4. Mining	5. Manu-facturing	6. Construc-tion	7. Transporta-tion	8. Electric Power	9. Gas & Water Systems Radio Broadcasting Telephone & Telegraph	10. Services	11. Intermed-iate	12. Personal Consumption	13. Final Demand	14. Total Output
1.Agriculture	.1550	.0081	.0000	.0000	.0034	.0001	.0000	.0000	.0000	.0000	.0033	.0248	.0068	.0050
2.Forestry	.0065	-.0025	.0105	.0018	.1429	.0085	.0000	.0000	.0000	.0000	.0286	.0064	.0163	.0229
3.Fishing	.0000	.0000	.0000	.0000	.0399	.0000	.0000	.0000	.0000	.0000	.0169	.0000	.0136	.0153
4.Mining	.0000	.0000	.0325	.0000	.0075	.0089	.0001	.0000	.0000	.0000	.0033	.0000	.1217	.0595
5.Manufacturing	.1300	.0071	.0977	.0179	.0494	.2053	.4550	.0030	.0091	.0195	.0754	.2735	.1191	.0962
6.Construction	.0527	.0092	.0076	.0109	.0039	.0002	.0097	.0504	.0503	.0512	.0214	.0000	.1912	.1020
7.Transportation	.0293	.0113	.0254	.1820	.0169	.1049	.0246	.0104	.0114	.0521	.0677	.0806	.0460	.0574
8.Electric Power	.0144	.0001	.0000	.0107	.0324	.0019	.0060	.0000	.0102	.0046	.0080	.0099	.0075	.0078
9.Gas & Water Systems Radio Broadcasting Telephone & Telegraph	.0057	.0084	.0032	.0040	.0016	.0027	.0080	.0002	.0316	.0129	.0072	.0069	.0056	.0064
10.Services	.0545	.0450	.0365	.0715	.0205	.1430	.1303	.0257	.0445	.0790	.0865	.3741	.2265	.1530
11.Intermediate Total	.4782	.0867	.2139	.2969	.3184	.4678	.2242	.0897	.1570	.2193	.3184	.7439	.7544	.5253
12.Household Income	.3999	.7117	.6948	.2676	.1641	.3558	.5610	.2069	.5387	.4705	.4140	.0000	.0002	.2203
13.Final Demand	[illegible]	.9133	.7861	.7011	.6816	.5321	.7758	.9103	.8428	.7807	.6914	.2561	.2453	.4752
14.Total Output	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

coefficients we have only taken into account the new industries that were not in existence before. Since we are forecasting for a short time period into the future it is not likely that the technology of the existing industries will change very much. However, account has to be taken of the new industries which were not in existence in the Newfoundland economy. Table 5 shows the coefficient table used to predict future growth in electricity demand. It is the same as table 6 except for the manufacturing column.

The method of calculating the demand for electricity created by the expansion of industrial activity is to take the predicted 1972 final demand for each industry (column 2 table 10) and multiply it through the appropriate column in the coefficient table in order to obtain the "round expansion." Thus in order to obtain the second round expansion for the agriculture industry we take the predicted 1972 final demand (6.2 million) and multiply it by .1550. We take the predicted final demand in forestry of 12.6 million and proceeding down the agriculture column in the input-output table multiply it by .0065. Thus, by cummulative multiplications we take each sector of the economy, multiply its forecasted final demand by the appropriate coefficient in the agriculture column, and when we have completed the process our figure of $1.9 million gives us the second round expansion in the agriculture sector (column 3). We do this for each sector until we have found the second round

Table 10

[illegible] (Not including Household [illegible])
([illegible])

	1. Value Added	2. Final Demand	3. Second Round Expansion	4. % to be Produced in Nfld.	5. Second Round Total	6. Third Round Expansion	7. Third Round Total	8. r=.3522	9. Extrap-olation	10. Total of Expansions
1. Agriculture	5	6.2	1.9	48.91	.93	.64	.31	.3333		
2. Forestry	34	12.6	37.8	98.97	37.41	8.31	8.22	.2197		
3. Fishing	33	17.7	9.6	100.00	9.60	2.27	2.27	.2364		
4. Mining	134	185.6	5.6	98.83	5.53	3.17	3.13	.5660		
5. Manufacturing	212	239.6	116.3	49.00	56.99	49.93	24.47	.6048		
6. Construction	217	362.3	16.9	100.00	16.90	7.32	7.32	.4331		
7. Transportation	60	44.1	38.6	99.95	38.56	11.72	11.71	.1322		
8. Electric Power	41	20.7	11.8	100.00	11.80	2.98	2.98	.2525	1.05	36.53
9. [illegible] Radio Broadcasting Telephone & Telegraph	12	5.9	5.5	100.00	5.50	2.60	2.60	.4727		
10. [illegible]	237	204.3	64.5	100.00	94.40	25.64	25.64	.2716		

expansion that will be created in each industry. Each figure shows the value of additional production necessary in each sector to sustain the 1972 predicted increase in final demand. However, not all this additional productivity will be created in Newfoundland, since Newfoundland does not produce everything that it consumes. Thus we have to multiply each appropriate expansion by the percent of the additional productivity that will be produced in Newfoundland. Thus, as we have seen, the output expansion in the agriculture industry in the second round was $1.9 million. However, only 48.91 percent[1] of agriculture demand is met by production in Newfoundland (column 4) and hence we multiplied $1.9 million by 48.91 percent in order to arrive at the second round total of $0.93 million (column 5). This operation has to be carried out due to the fact that since we are forecasting electric power demand in Newfoundland we are only interested in the increased output that will be generated in the Newfoundland economy, since it is only the activity in the Newfoundland economy that will generate more electric power demand.

Once we have obtained the additional production necessary in the second round to sustain the forecasted final (column 5) we start the process described above all over again. The reason for this is that to produce these second

---

[1]The source for all the data in column 4 was the material available in the 1960 input-output tables as published by Atlantic Development Board, Ottawa.

round expansions requires in turn a whole new series of inputs for the producing sectors. We continue the above mentioned calculations until the expansion for each sector is smaller than it was in the previous round, by which time the convergence is apparent, and extrapolations were made to cover the infinite number of succeeding rounds. In table 10 convergence was obtained after only three rounds, after which time an extrapolation on the electric industry only was made, since we are only interested in the future demand created for the electric power industry.

The second method that we used to predict future electricity consumption was to follow the same procedure as outlined above with the exception that we have now included the household sector of the economy. We have moved the household sector from its autonomous sector in which it appears in the input-output table and have included it within the internal structure of the table. In other respects, the basic transactions table remains unchanged. By moving the household sector of the economy into the processing sector we can ascertain what additional demand has been created for electric power by households or private consumers other than the industrial sectors. The expansions in output are illustrated in table 11. With the inclusion of the household sector we have to calculate the round expansions until the fifth round, after which we have extrapolated since the expansion in the fifth round was less than the expansion in

Table 11

[illegible] ([illegible] Household [illegible])
(Millions)

	1. Value Added	2. Final Demand	3. Second Round Expansion	4. [illegible]	5. Second Round Total	6. Third Round Expansion	7. Third Round Total
1. Agriculture	5	6.2	1.9	49.91	.93	9.30	4.79
2. Forestry	34	12.6	37.3	93.97	37.41	10.68	10.57
3. Fishing	33	17.7	9.6	100.00	9.60	2.27	2.27
4. Mining	134	195.6	5.6	98.83	5.53	3.17	3.13
5. Manufacturing	212	239.6	116.4	49.00	57.04	151.12	74.05
6. Construction	217	362.3	16.9	100.00	16.90	7.32	7.32
7. Transportation	90	[illegible].1	33.6	99.95	33.56	41.54	41.52
8. Electric Power	41	20.7	11.8	100.00	11.80	6.64	6.64
9. [illegible] Water Systems Radio Transmitting Telephone & Telegraph	12	5.6	5.5	100.00	5.50	5.15	5.15
10. Services	227	264.3	64.5	100.00	64.50	164.05	164.05
12. Household Income		0.32	369.95		369.95	150.07	150.07

	8. Fourth Round Expansion	9. Fourth Round Total	10. Fifth Round Expansion	11. Fifth Round Total	12. r=.6203	13. Extrapolation	14. Total of Expansions
1. Agriculture	4.48	2.35	3.93	1.87	.7957		
2. Forestry	11.69	11.57	5.80	5.74	.4961		
3. Fishing	2.95	2.95	1.36	1.36	.4610		
4. Mining	0.70	0.69	0.44	0.43	.6231		
5. Manufacturing	69.34	33.98	53.15	26.04	.7663		
6. Construction	10.09	10.09	5.11	5.11	.5064		
7. Transportation	24.70	24.69	17.41	17.40	.7047		
8. Electric Power	5.06	5.06	2.49	2.49	.4920	1.54	48.23
9. [illegible] Water Systems Radio Transmitting Telephone & Telegraph	3.91	3.91	2.44	2.44	.6240		
10. Services	79.66	79.66	61.84	61.84	.7361		
12. Household Income	131.23	131.23	74.59	74.59	.5683		

the fourth round for all industries. In this case also we have summed the expansions of solely the electric power industry since we are only interested in the demand created for electric power.

From tables 10 and 11 the calculated total output or demand for electricity is $48,230,000 when the household sector is included, and $36,530,000 without the household sector, to give a difference of $11,700,000, which is the induced demand created by the household sector.

The induced demand for electric power due to the household sector in 1972 has been forecast at $11,700,000, in 1960 prices. In 1960 the revenue from domestic and farm sales of electricity was $3,901,000.[1] The generation of electricity to domestic and farm service was 169,481,000[2] kilowatt-hours. The domestic and farm sector as calculated by the Dominion Bureau of Statistics is roughly equivalent to the household sector in the input-output table. By calculating the price paid per kilowatt-hour and applying this to the induced demand in value terms created by the household sector of the economy, we calculate that household demand for electricity in 1972 will be approximately 509 million kilowatt-hours.

To find the demand for the industrial sector of the

---

[1] D.B.S. Electric Power Statistics, 1960. Catalogue No. 57-202

[2] Ibid.

economy is slightly more complicated. Since there are numerous different prices charged for electricity (the charge depends upon the amount of power used. Many of the new industries also have private contracts to receive power at a subsidized rate, and the price paid for power is considered confidential.) We have ascertained the average price paid for electricity by the industrial sector of the economy. In 1960 the total amount of power generated was 1511[1] million kilowatt-hours. As was just calculated, the household sector used 169 million kilowatt-hours, to leave 1342 million kilowatt-hours for industrial use. In 1960 the total revenue received from the generation of power was $11,258,000.[2] The revenue received from the household sector was $3,901,000, to give a difference of $7,357,000 which is the revenue received from the industrial sector. By calculating the price paid per kilowatt-hour and applying this to the demand for electricity in 1972 in value terms, we find that the demand in quantity terms will be approximately 6666 million kilowatt-hours. To this we can add the household demand of 509 million kilowatt-hours to give a total forecasted demand of 7175 million kilowatt-hours.

---

[1] Ibid.

[2] Ibid.

Chapter 5

RECAPITULATIONS AND RECOMMENDATIONS

Social overhead capital can be defined as capital which must be either invested by the government because the benefits from such an investment accrue to society as a whole, and thus the provision of these facilities would be primarily the concern of government; or because of technical economic reasons the facilities are best operated in the form of a monopoly which thus is subject to government control. Electricity is one form of social overhead capital. Governments should provide social overhead capital facilities such as electric power because these facilities are essentially permissive, for an excess supply of social capital facilities can serve to motivate private investment, while a deficiency of supply (ie. excess demand) may discourage private investment. This is especially true in Newfoundland at the present time, since the policy of the government is to attract power intensive industries. Electric Power is of great importance to Newfoundland at the present time, for by its policy of subsidized power to large industrial users, the government is attempting to attract many new industries.

In order for any policy of this nature to be effective, future demands have to be quantified, in order to ensure that bottlenecks do not occur, so that a situation in which there is a shortage of supply will not materialize. Development is usually severely hindered if such bottlenecks in supply are encountered. The future demand projections should ideally be within the range of available supply.

The growth of the electric power industries in the past was not as important as it will be in the future, for in the past the new power intensive industries were not in existence, and the growth of electric power generation was largely due to the fact that electricity was extended to people who had never had the benefits of electric power. However, now that the majority of people do receive electric power, the emphasis is going to be on providing electric power to industries which will be induced to locate in Newfoundland due to the availability of power. In the past, bottlenecks in power were experienced, and industrial expansion was forced to halt, as happened before the completion of the first phase of the Bay d'Espoir development in the spring of 1967. To avoid the recurrence of such events careful planning is required.

The present situation in the electric power industry is a reflexion of past history. Although great improvements have occured in the past few years, such as the completion of the "island grid," and the availability of more power from such developments as Bay d'Espoir, there is not yet a real plan for the future. Although the power intensive industries are being encouraged to locate in Newfoundland, no real plan has yet been formulated to decide upon future supply. It seems that transmission of power from Churchill Falls may not prove economical. Thus, although vast amounts of electric power will be generated by Newfoundland, paradoxically it will not be available to Newfoundland, at least not to the Island, where most people live and most industries are located. The problem thus becomes one of planning to see where the source of supply will be. Before planning the supply, however, the future demand has to be examined.

Demand projections were made for 1972. The reason for deciding upon this year in particular is that we can make fairly accurate predictions for 1972. We know with a high degree of certainty what will happen, in the sense that it is known which industries will be in production by that date. If we forecast for a time period which is too long in the future, the forecast will not be too accurate, becouse there will be too many uncertainties.

The year 1972 was also chosen because of our method of analysis - the interindustry approach. The reasons why this method was chosen, and its advantages, were expressed in chapter 3. However, by using this approach, we had to employ input-output tables which were constructed for 1960. Although we changed the coefficients in the manufacturing column, to take account of the change in technology, we assumed that the technology in the other sectors would remain constant. This is perhaps a valid assumption when forecasting for a short time period into the future, for it is unlikely that great changes will take place in technology in a short time period. By forecasting for 1972 we avoided the problem of changes in technology, and also were quite certain of the events that will occur in the period between 1969 and 1972.

The total projected demand for electric power in 1972 is 7175 million kilowatt-hours. Of this total, 509 million kilowatt-hours is induced demand created by the household sector of the economy, and 6666 million kilowatt-hours is direct and indirect demand created by the industrial sector of the economy.

The total equivalent generation[1] for 1972 estimated by the Newfoundland and Labrador Power Commission[2] is 6543 million kilowatt-hours. The total capacity[3] estimated for 1972 is 7185 million kilowatt-hours. However, dependable

---

[1] The equivalent generation is the forecasted Island load plus the lossed in generation to give the total amount of generation required to meet the anticipated demand by the Power Commission.

[2] "Isolated Island Development," Newfoundland and Labrador Power Commission.

[3] Total capacity is the amount of power that can be generated under normal conditions.

total generation[1] for 1972 is only 6671 million kilowatt-hours.

The conclusion that can be drawn from this is that if 1972 is an average year, so that the amount of electricity that can be generated is the same as that defined under "total capacity," no problems should be encountered, since the "total capacity" is approximately the same as forecasted demand.

However, since supply and demand as forecasted for 1972 are approximately the same, problems may occur, especially if the planned hydro generation is less than capacity because of lower than average stream run-off. Problems should also occur because bottlenecks may occur, due to the fact that no excess supply is forecasted. This will curtail industrial expansion. For example, there is a possibility that a new aluminum plant[2] may commence production, which

---

[1]Dependable generation is lower than total capacity. This is due to the fact that total capacity takes into account the amount that the hydro plants can generate in a normal year, whereas dependable total generation only takes account of what the hydro plants can generate if there is a lack of run-off due to dry weather.

[2]Evening Telegram, January 29, 1969. P. 3

would require 1740[1] million kilowatt-hours of electricity. With the forecasted supply in 1972 approximately the same as forecasted demand, no excess supply will be available, and hence the aluminum plant could not have its required supply. Unless new generating capacity will be available, this development, and perhaps others as well, will be impeded. Unless power is transmitted from Churchill Falls to the Island of Newfoundland, shortages of power are imminent. Yet, all indications at the present time point to the fact that such transmission of power would prove uneconomic.

What are the policy implications of this? Since total demand approximately equals total supply, the available supply to the individual sectors should be distributed in an economic manner. The best method of distributing power is to supply those sectors which add most to the gross provincial product of Newfoundland. Since the manufacturing sector of the economy is the most important in this respect, the policy should be to supply this sector of the economy with the

---

[1]This calculation is fairly straightforward. The aluminum plant is supposed to employ 1300 men. To produce 1 ton of aluminum takes 30 man-hours of labor and 20,000 kilowatt-hours of electricity. (The Review of Economics and Statistics XXXIX 1957, P. 201) Assuming a 40 hour work week and 50 work weeks in a year, the plant should produce 87,000 tons of aluminum per year. Since it requires 20,000 kilowatt-hours of electricity to produce 1 ton of aluminum, 87,000 tons will requre 1740 million kilowatt-hours.

required power, especially if new industries are to be induced into Newfoundland. It seems that the prospects of the individual firms which compose the manufacturing sector is quite good. The pulp and paper industry has available its required resources, and its market outlook is also brighter after a period of deficient demand for the products of this industry. The market for the new industries is also apparently ensured, for extensive market surveys were performed prior to their introduction into Newfoundland. Because the manufacturing sector of the economy is of such great importance to the economy of Newfoundland, electric power should not be denied to it. However, attempts should also be made to ensure that the required supply of electric power is always available, so that shortages do not occur in the future, and hence the opportunity to induce additional industries is not missed.

Appendix 1

RURAL ELECTRIFICATION 1959-1969

NO.	AREAS	DATE IN SERVICE	PRESENT NO. OF CUSTOMERS	MILES OF LINE	VOLTAGE
	LABRADOR				
1.	Cartwright	1966	91	1.5	2.4 KV
2.	Happy Valley	1959	1060	12	4.16/12.5
3.	Hopedale	1966	50	1	2.4 KV
4.	Makkovik	1966	60	1	2.4 KV
5.	Marys Harbour	1966	60	3	2.4 KV
6.	Mud Lake	1967	36	.5	4.16 KV
7.	Nain	1968	80	1	2.4 KV
8.	Northwest River	1967	119	3	2.4 KV
9.	Postville	1966	25	1	2.4 KV
10.	South Labrador	1966	374	58	25 KV
	TOTALS		1955	82.0	
	ISLAND OF NEWFOUNDLAND				
1.	Back Line - Goulds	1967	5	1	7.2 KV
2.	Bacon Cove	1965	15	4	2.4 KV
3.	Bay L'Argent	1966	639	41	14.4/25 KV
4.	Beau Bois	1964	11	2	7.2 KV
5.	Belleoram	1966	324	15.5	14.4/25 KV
6.	Bellevue	1960	639	77	7.2/12.5 KV
7.	Big Salmonier	1964	7	1	7.2 KV

.... 2

RURAL ELECTRIFICATION 1959-1969

NO.	AREAS	DATE IN SERVICE	PRESENT NO. OF CUSTOMERS	MILES OF LINE	VOLTAGE
8.	Bonaventure	1965	60	5	7.2 KV
9.	Bonavista North	1961	473	10	7.2 KV
10.	Bonne Bay	1964	761	20	7.2/12.5 KV
11.	Boyds Cove - Horwood	1965	115	40	7.2/12.5 KV
12.	Brents Cove	1967	46	2	7.2 KV
13.	Brighton	1969	58	4	12.5 KV
14.	Brigus Road Extension	1962	6	2	2.4 KV
15.	Buchans Junction	1968	20	5	7.2 KV
16.	Burgeo	1961	399	4	2.4 KV
17.	Burlington	1965	182	7	2.4/7.2 KV
18.	Campbellton - Loon Bay	1965	45	7	7.2/12.5 KV
19.	Cape Ray	1966	51	2.5	2.4 KV
20.	Cape Shore	1966	302	6.5	25 KV
21.	Caplin Cove	1963	50	3	2.4 KV
22.	Carmanville	1965	460	32	25 KV
23.	Change Islands	1965	165	3	2.4 KV
24.	Charlottetown	1965	75	7	7.2 KV
25.	Clarenville Extension	1967	1	1	7.2 KV
26.	Coachmans Cove	1968	60	2	7.2 KV
27.	Codroy	1962	358	60	7.2 KV
28.	Coffey Cove	1966	10	4	7.4 KV
29.	Colinet	1960	897	76	7.2/12.5/14.4 25 KV
30.	Colliers Extension	1966	20	1	2.4 KV
31.	Cooks Harbour	1967	114	11	7.2 KV

.... 3

RURAL ELECTRIFICATION 1959-1969

NO.	AREAS	DATE IN SERVICE	PRESENT NO. OF CUSTOMERS	MILES OF LINE	VOLTAGE
32.	Cormack	1966	93	6	7.2 KV
33.	Cow Head	1966	288	8	2.4/7.2 KV
34.	Critches Car Road	1962	10	1	7.2 KV
35.	Daniels Harbour	1968	80	3	7.2 KV
36.	Dildo South - Spreadeagle	1966	50	4	7.2 KV
37.	Duntarra	1965	70	3	7.2 KV
38.	Eastport	1963	180	12	7.2 KV
39.	Englee	1966	194	2	7.2 KV
40.	English Harbour East	1968	41	2	7.2 KV
41.	Fairhaven	1966	31	2	2.4 KV
42.	Fleur de Lys	1968	100	2	7.2 KV
43.	Flowers Cove	1966	617	61.5	12.5 KV
44.	Fogo Island	1965	1,132	25	25 KV
45.	Francois	1966	68	1	2.4 KV
46.	Gallants - Spruce Brook	1966	50	7	2.4 KV
47.	Gander Bay	1965	--	26	12.5 KV
48.	Gaultois	1966	116	2	2.4 KV
49.	Georgetown / Brigus	1962	19	1	2.4 KV
50.	Grand Bay West	1967	25	.5	2.4 KV
51.	Grand Le Pierre	1968	49	.75	2.4 KV
52.	Greenspond	1965	130	2	2.4 KV
53.	Hampden	1965	169	5	2.4 KV
54.	Harbour Breton	1962	315	3	2.4 KV
55.	Harbour Deep	1968	66	1.5	2.4 KV

.... 4

RURAL ELECTRIFICATION 1959-1969

NO.	AREAS	DATE IN SERVICE	PRESENT NO. OF CUSTOMERS	MILES OF LINE	VOLTAGE
56.	Heavy Tree Line	1966	10	2	7.2 KV
57.	Hermitage	1966	304	23.5	14.4/25 KV
58.	Holyrood Extension	1967	10	1.5	7.2 KV
59.	Hooping Harbour	1968	40	.5	2.4 KV
60.	Isle aux Morts	1966	550	48	25 KV
61.	Jacksons Arm	1966	92	3	7.2/12.5 KV
62.	Jackson Cove - Harry Harbour	1967	110	10	7.2 KV
63.	Kings Point	1965	200	2	2.4 KV
64.	Lake View	1968	4	.2	7.4 KV
65.	Lark Harbour	1968	157	16	14.4 KV
66.	La Scie	1962	277	18	2.4/7.2/12.5K
67.	Little Bay	1968	90	5	2.4 KV
68.	Little Bay Island	1961	114	2	2.4 KV
69.	Long Harbour	1960	65	12.5	7.2/12.5 KV
70.	Low Point	1966	20	3	7.2 KV
71.	Lumsden - Cape Freels	1964	140	8	7.2 KV
72.	Maberly	1963	25	10	7.2 KV
73.	Main Brook	1966	239	3	2.4 KV
74.	Merasheen	1965	--	2	2.4 KV
75.	Millertown	1967	142	2	7.2 KV
76.	Mings Bight	1969	50	2	7.2 KV
77.	Mooring Cove	1965	35	6	7.2 KV
78.	Muddy Brook	1962	6	1	7.2 KV
79.	Musgrave Harbour / Doting Cove	1963	30	4	2.4 KV

.... 5

RURAL ELECTRIFICATION 1959-1969

NO.	AREAS	DATE IN SERVICE	PRESENT NO. OF CUSTOMERS	MILES OF LINE	VOLTAGE
80.	New Harbour	1965	5	2	7.2 KV
81.	Newtown	1962	167	6	7.2 KV
82.	New World Island	1964	985	45	7.2/14.4 KV
83.	Nippers Harbour	1966	71	2	2.4 KV
84.	Pacquet / Woodstock	1969	90	5	7.2 KV
85.	Plate Cove	1965	200	20	14.4 KV
86.	Point au Mal	1961	52	5	7.2 KV
87.	Point Leamington	1962	180	17	14.4 KV
88.	Point May	1965	72	9	7.2 KV
89.	Port aux Choix/Port Saunders	1966	368	20	2.4/7.2 KV
90.	Port au Port	1964	150	21	2.4 KV
91.	Port Blandford	1961	300	20	7.2 KV
92.	Port Elizabeth	1965	86	2	2.4 KV
93.	Queens Cove	1962	567	68	7.2 KV
94.	Ramea	1964	258	1.5	2.4 KV
95.	Random Island	1965	357	50	7.2/12.5 KV
96.	Rencontre East	1968	65	2.0	2.4 KV
97.	Renews/Cappahayden	1962	17	5	7.2 KV
98.	Roberts Arm	1965	315	12	2.4/7.2 KV
99.	Robinsons	1960	624	18	14.4 KV
100.	Roddickton	1964	312	2	2.4 KV
101.	St. Albans / Milltown	1965	791	25	25 KV
102.	St. Anthony	1961	612	15	2.4 KV
103.	St. Brendans	1966	129	12	2.4 KV

RURAL ELECTRIFICATION 1959-1969

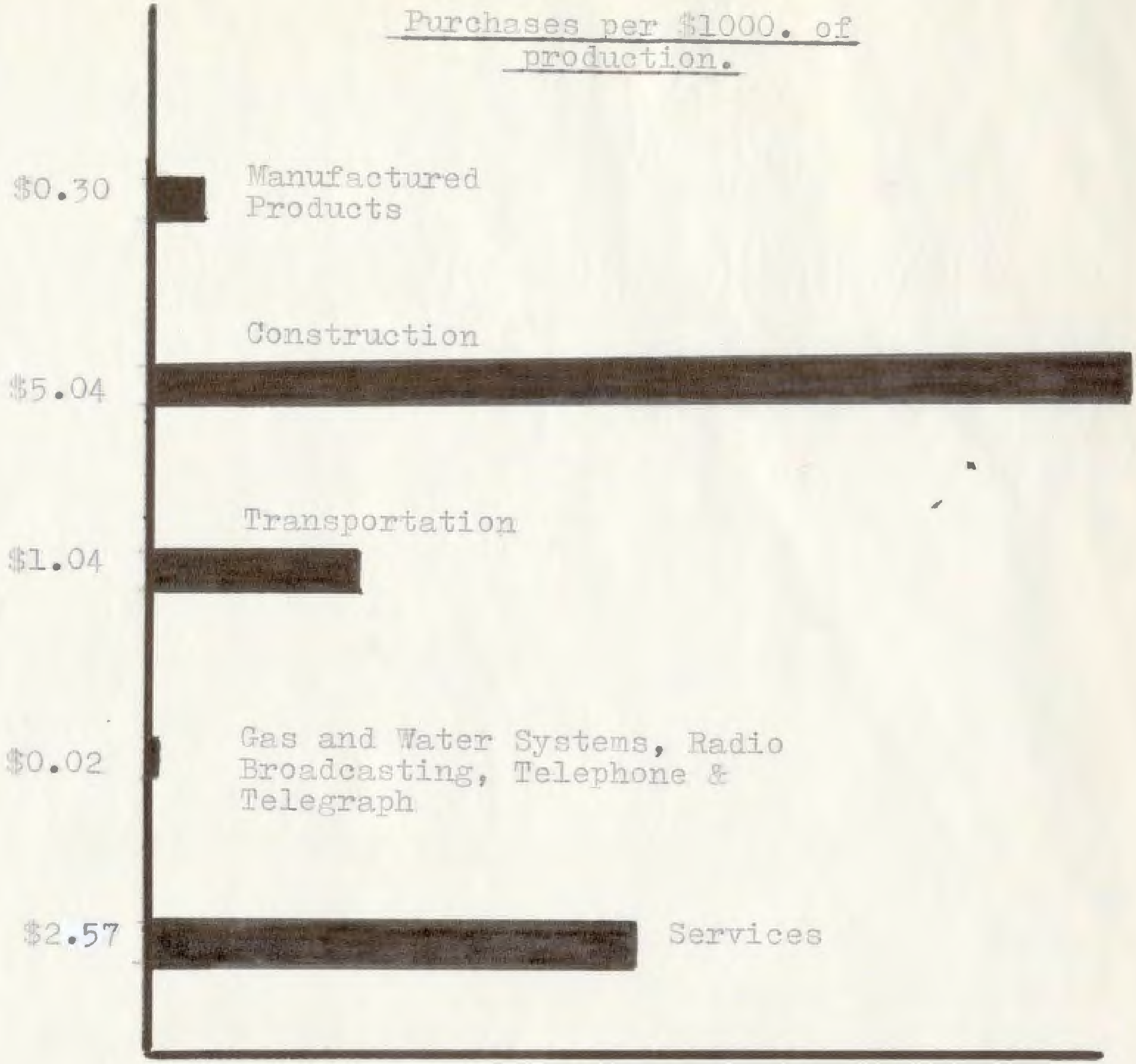
NO.	AREAS	DATE IN SERVICE	PRESENT NO. OF CUSTOMERS	MILES OF LINE	VOLTAGE
104.	St. Lunaire - Griquet	1967	122	9	2.4 KV
105.	St. Patricks	1965	30	1	2.4 KV
106.	Seal Cove	1966	60	10	7.2 KV
107.	Ship Harbour	1965	45	8	7.2 KV
108.	Snooks Arm	1967	20	1	2.4 KV
109.	Sops Arm	1966	186	2	7.2/12.5 KV
110.	South Brook	1966	156	5	7.2/12.5 KV
111.	Spanish Room / Rock Harbour	1964	25	3	7.2 KV
112.	Spillers Cove	1965	26	5	7.2 KV
113.	Summerside	1967	5	3	7.2 KV
114.	Sweet Bay	1963	77	5	2.4 KV
115.	Swift Current Area	1964	200	20	7.2 KV
116.	Terra Nova	1961	47	2.5	2.4 KV
117.	Terrenceville	1965	128	2	2.4 KV
118.	Tilt Cove	1968	25	5	2.4 KV
119.	The Thicket (Harbour Grace)	1960	12	2	7.2 KV
120.	Trepassey	1960	421	41	2.4/7.2 KV
121.	Trinity Bay South	1964	650	70	7.2 KV
122.	Triton	1962	188	5	2.4 KV
123.	Trouty	1961	29	20	7.2 KV
124.	Twillingate	1961	720	8	2.4/7.2 KV
125.	Wesleyville	1964	400	35	7.2 KV
126.	Whitbourne Extension	1967	5	1	7.2 KV
127.	Wild Bight	1965	60	5	2.4 KV

.... 7

RURAL ELECTRIFICATION 1959-1969

NO.	AREAS	DATE IN SERVICE	PRESENT NO. OF CUSTOMERS	MILES OF LINE	VOLTAGE
128.	Winterbrook	1965	150	12	14.4 KV
129.	Witch Hazel Road	1966	10	1	7.2 KV
130.	Woody Island	1965	32	1	2.4 KV
	TOTALS		23573	1489.95	

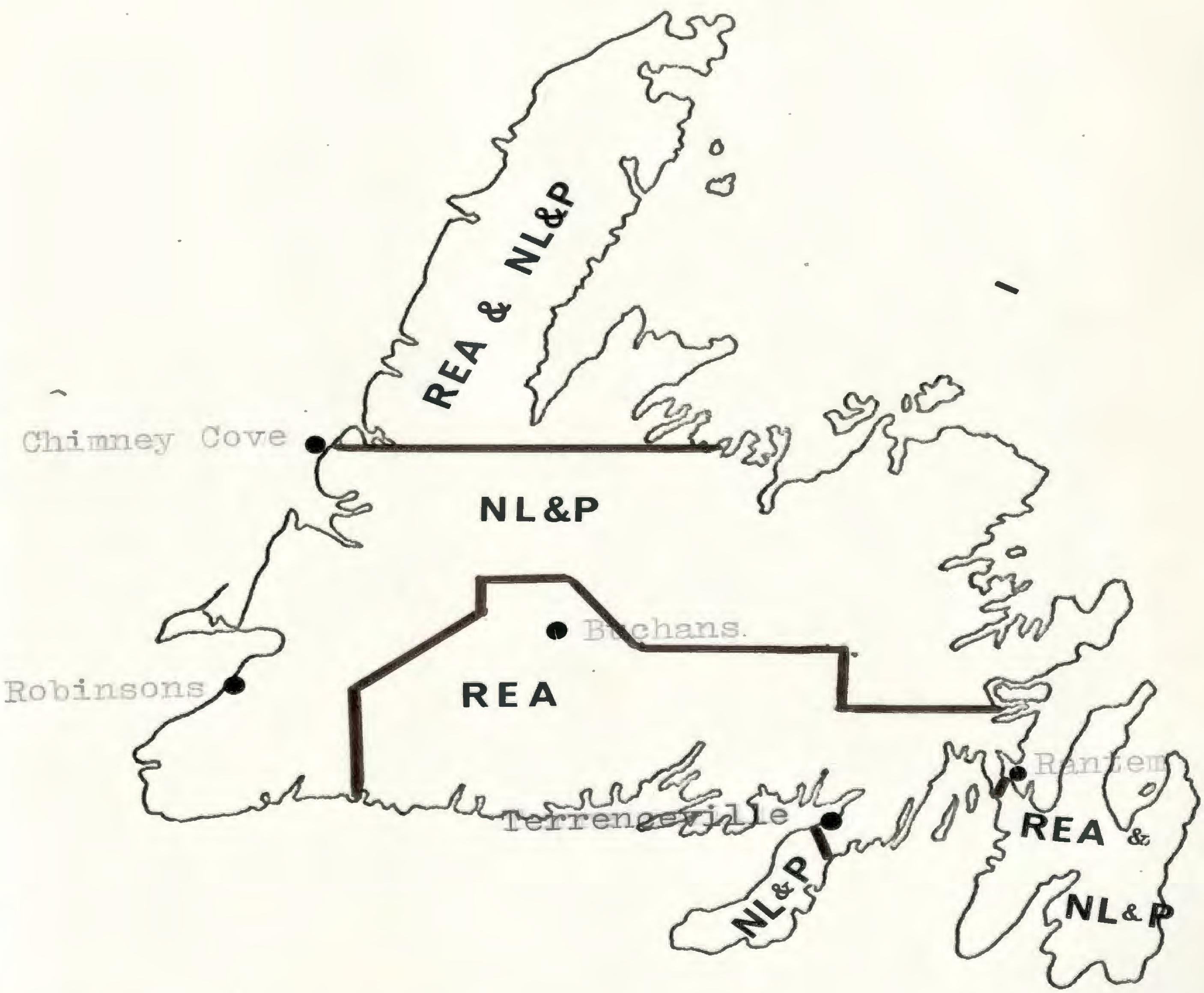
Appendix 2



Input to the electric power industry per $1000. of electric production. Comparison of these figures with the new 1965 matrix figures would show changes in the input structure of the industry due to changes in prices and technology.

Appendix 3

Areas In Newfoundland In Which Various Authorities Have The Main Distribution Of Electricity Rights.



R.E.A. –– Rural Electrical Authority.

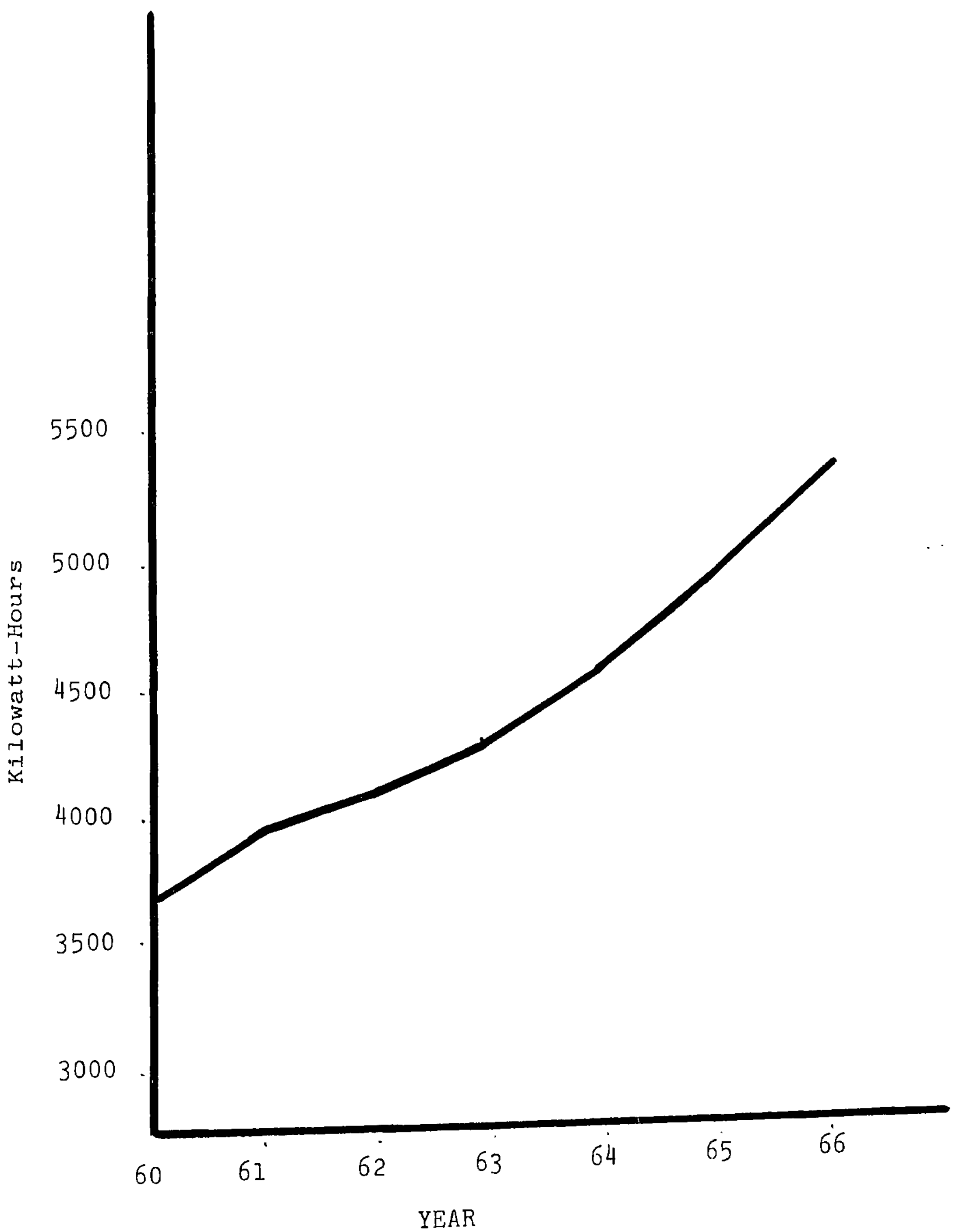
N.& L.P.C. -- Newfoundland and Labrador Power Commission

N.L.& P. ---- Newfoundland Light and Power Co. Ltd.

Appendix 4

Annual Per Capita Consumption Of Electricity

1960 - 1966



Appendix 5

The basic activity matrix: Atlantic Development Agency Industries. These are basically the new industries which were used to change the manufacturing column in the coefficient table. The coefficients were changed by finding the new increased total output as a result of these industries and the inputs into the manufacturing sector which are required to support this increased output. New coefficients can thus be found from the old flow table. We ascertain adjusted total output by adding the new output from the A.D.A. Industries to the old output in the input-output table, to get adjusted total output. The same procedure is applied to the inputs, to ascertain the adjusted inputs into the manufacturing sector. The new coefficient column was thus obtained by dividing the adjusted inputs from each sector into the manufacturing sector by the adjusted total output, to get the new adjusted coefficient column.

In the table inputs are denoted by a negative sign (-) in front of the appropriate figure, and outputs are denoted by a positive sign (+) in front of the appropriate figure. In the trade sector a positive sign (+) denotes imports and a negative sign (-) denotes exports.

M= Imports

X= Exports

P_1, P_2, etc. show different stages of the manufacturing process, where the manufactured product can be sold as an end product in several production stages. For instance, under newsprint we can see that some output was sold in the form of sulphite pulp, other output in the form of mechanical pulp, while most of the output was of course sold in the form of newsprint.

Source: "Economic Impact of Two Growth Regions in Newfoundland: An Application of Industrial Complex Analysis." Chapter 2. An unpublished M. A. thesis by David Wells, Memorial University of Newfoundland.

TABLE [illegible] THE BASIC ACTIVITY MATRIX: [illegible]

	Petroleum Refining			Anhydrous Ammonia		Newsprint					Linerboard				Phosphorus			Magnesium Hydroxide				Aluminum Cable		Brewery	
	M	P	X	P	X	M	P_1	P_2	P_3	X	P_1	P_2	P_3	X	M	P	X	M	P_1	P_2	X	M	P	M	P
1 Crude Oil	+87,243,730	-87,243,730																							
2 Jet Fuel		+120,839,160	-120,835,160																						
3 Sulphur		+ 235,000					- 43,350																		
4 Hydrogen		+ 9,440,056		- 9,440,056																					
5 Anhydrous Ammonia				+33,120,000	-33,120,000													+174,852	-174,852						
6 Wood							-564,507	-5,092,461			-18,238,615														
7 Limestone							- 9,645																		
8 Coal and Coke						+[illegible]	-327,[illegible]																		
9 Water															[illegible]	[illegible]				[illegible]					
10 Sulphite Pulp							+[illegible]		-1,[illegible]																
11 Mechanical Pulp								+11,[illegible]	-1,190,273																
12 Newsprint									+24,566,434	-24,566,434		+27,[illegible]	+27,166,[illegible]												
13 Wood Print																									
14 Linerboard													[illegible]	[illegible]											
15 Phosphate Rock															[illegible]	[illegible]									
16 Silica Quartz																[illegible]									
17 Carbon Electrode															[illegible]	[illegible]									
18 Phosphorus																[illegible]	[illegible]								
19 Sulphuric Acid																									
20 Sea Water																		[illegible]		[illegible]					
21 Magnesium Hydroxide																				[illegible]	[illegible]				
22 Steel Core Wire																						[illegible]	[illegible]		
23 Aluminum Redraw Rod																						[illegible]	[illegible]		
24 Aluminum Cable																							[illegible]		
25 Yeast																								[illegible]	[illegible]
26 Sugar																								[illegible]	[illegible]
27 Malt (Barley)																								[illegible]	[illegible]
28 Hops																								[illegible]	[illegible]
29 Rice & Corn Flakes																								[illegible]	[illegible]
30 Beer																									[illegible]
[illegible] Fuel Oil							[illegible]	[illegible]														[illegible]	[illegible]		
[illegible] Electricity		- [illegible],000		- 3[illegible],000								-2,[illegible]				[illegible]				[illegible]			[illegible]		[illegible]
[illegible] Operating Labour		- 456,[illegible]		- [illegible]				[illegible]				-1,519,000				[illegible]				[illegible]			[illegible]		[illegible]
[illegible] Plant Investment		-[illegible],730,000		-2[illegible],850,000				[illegible]				-7[illegible],900,000				-3[illegible]				[illegible]			[illegible]		[illegible]

		Fish Processing M	Fish Processing P_1	Fish Processing P_2	Fish Processing P_3	Fish Processing X	Dairy M	Dairy P	Bakery M	Bakery P	Soft Drinks M	Soft Drinks P	Metal Fabricating M	Metal Fabricating P
25	Yeast								+3,370	-3,370				
26	Sugar								+7,100	-7,100	+28,000	-28,000		
31	Fresh Fish		-4,802,300	-1,644,900	-13,200									
32	Frozen Fish		+9,785,301			-9,680,600								
33	Fishmeal			+2,741,500		-2,741,500								
34	Fish Oil				+22,000									
35	Cordage	+26,250	-96,150											
36	Packing & Bottling Material	+605,900	-513,575	-148,000	-1,325		+4,110	-4,110	+17,900	-17,900	+9,790	-9,790		
37	Butter						+47,500	-47,500						
38	Milk Powder						+9,860	-9,860	+2,400	-2,400				
39	Milk							+88,100						
40	Oils								+785	-785				
41	Shortening & Lard								+17,750	-17,750				
42	Baking Soda								+35	-35				
43	Spices & Salt								+530	-530				
44	Cocoa								+455	-455				
45	Corn Starch								+66	-66				
46	Eggs									-2,780				
47	Flour								+69,650	-69,650				
48	Cake Mixtures								+1,210	-1,210				
49	Fruits								+5,950	-5,950				
50	Pie Filling								+507	-507				
51	Gelatine								+192	-192				
52	Bakery Products									+342,400				
53	Concentrate										+42,000	-42,000		
54	CO_2 Gas											-10,490		
55	Soft Drinks											+223,800		
56	Steel												+410,000	-410,000
57	Steel Products													+871,000
58	Fuel Oil	+919,280	-712,400	-205,000	-1,880		+1,470	-1,470	+7,260	-7,260	+5,245	-5,245		
59	Electricity		-40,028	-2,055	-12			-1,200		-1,680		-3,000		-7,800
I	Operating Labour			-1,839,212				-21,850		-68,300		-65,660		-34,500
II	Plant Investment			-9,530,000				-21,980		-437,000		-267,500		-340,910

BIBLIOGRAPHY

Books

Baumol, William J., Economic Theory and Operations Analysis (Englewood Cliffs N. J.: Prentice Hall, Inc., 1965.)

Chalmers, Bruce, Emergy (New York: Academic Press, 1963.)

Chenery, H. B., Clark, P.G., Interindustry Economics (New York: John Wiley & Sons Inc., 1959.)

Dales, John Harkness, Hydroelectricity and Industrialization in Quebec (Cambridge: Harvard University Press, 1957.)

Dorfman, Robert A., Samuelson, Paul A., Solow, Robert M., Linear Programming and Economic Analysis (New York: McGraw Hill Co. Inc., 1958.)

Fisher, F. M., Kaysen C., The Demand for Electricity in The United States (Cambridge: Harvard University Press, 1967.)

King, John A., Economic Development Projects and Their Appraisal (Baltimore: Johns Hopkins Press, 1967.)

Krutilla, J. V., Eckstein, Otto, Multiple Purpose River Development (Baltimore: Johns Hopkins Press, 1958.)

Leontief, Wassily, Input-Output Economics (New York: Oxford University Press, 1966.)

Leontief, Wassily, Studies in the Structure of the American Economy (New York: Oxford University Press, 1953.)

Lewis, W.A., Development Planning (New York: Harper & Row, 1966.)

Little, I.M.D., The Price of Fuel (Oxford: Clarendon Press, 1953.)

Miernyk, William H., The Elements of Input-Output Analysis (New York: Random House, 1967.)

National Council of Applied Economic Research, Demand for Energy in India, 1960-1975 (New Delhi: Asia Publishing House, 1960.)

Nelson, W. Stewart, Mid Continent Area Power Planners: A New Approach to Planning in the Electric Power Industry (East Lansing, Mich.: The Institute of Public Utilities, Graduate School of Business Administration, Michigan State University, 1968.)

Nourse, Hugh O., Regional Economics (New York: McGraw Hill, 1968.)

Schurr, Sam H., Netschert, Bruce C., Energy in the American Economy, 1850-1975 (Baltimore: Johns Hopkins Press, 1960.)

Sporn, Philip, Energy: It's Production, Conversion, and Use (New York: MacMillan Co. Ltd., 1963.)

Van Der Tak, Herman G., The Economic Choice Between Hydroelectric and Thermal Power Developments (International Bank for Reconstruction and Development, World Stuff Occasional Papers Number One: Johns Hopskins Press, 1966.)

Articles

- Clopper, Almon, "Consistent Forcasting in a Dynamic Input-Output Model" The Review of Economics and Statistics XLV (May 1963), 148-162

- Fisher, Walter D., "Criteria for Aggregation in Input-Output Analysis" The Review of Economics and Statistics XL (1958), P. 250-260

- Leontief, Wassily, "Input-Output Economics" Scientific American (Oct. 1951)

- Leontief, Wassily, "The Structure of the U.S. Economy" Scientific American (April 1965)

- Markowitz, H.M., Manne. A.S., "On the Solution of Discrete Programming Problems" <u>Econometrica</u> (1957) P. 84-110

- Miller, Ronald E., "The Impact of the Aluminum Industry on the Pacific Northwest: A Regional Input-Output Analysis," <u>The Review of Economics and Statistics</u> <u>XXXIX</u> (1957) P. 200-209.

- Samuelson, Paul A., "Economic Forecasting and Science" <u>The Michigan Quarterly Review</u> (Oct. 1965) P. 274-280.

<u>Government Documents</u>

Boni, Watkins, Jason & Co. Inc. "Economic Outlook for Province of Newfoundland" New York 1969.

Davis, John, "The Economics of Nuclear Power in Canada" Brief presented at the Special Committee of Research, House of Commons, Ottawa, June 1, 1961.

Canada Year Book 1967-78

Dominion Bureau of Statistics, "Electric Power Statistics" 1956-1966. Catalogue No. 57-202

Dominion Bureau of Statistics "National Accounts Income and Expenditure" 1956-1966, Catalogue No. 13-201

Dominion Bureau of Statistics "Survey of Production" 1964-65 Catalogue No. 61-202

"Manitoba Input-Output Conference," sponsored by Manitoba Economic Consultative Board and Dominion Bureau of Statistics, Winnipeg, March 1967.

Newfoundland and Labrador Power Commission Annual Report, 1967

"Report of the Royal Commission on Economic State and Prospects of Newfoundland and Labrador." St. John's, December 1967.

"Report of the Royal Commission on Electrical Energy" St. John's, February 1966

Reports

Newfoundland Light and Power Company Limited, "Annual Report," 1967

"Outlook for Energy in the United States," Energy Division, The Chase Manhattan Bank, New York, 1968.

"Power in the North," Bank of Montreal Busi
September 27, 1968