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HARZA ENGINEERING COMPANY CONSULTING ENGINEERS

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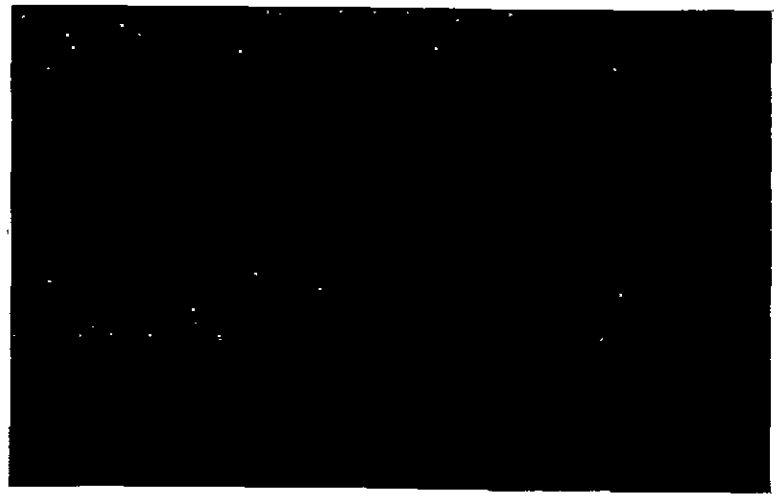

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FINAL DRAFT REPORT

KAJAKAI SERVICE AREA

HELMAND-ARGHANDAB VALLEYS, AFGHANISTAN

POWER MARKET STUDY

PHASE I

POWER MARKET SURVEY

Prepared for
United States Agency
for
International Development
Contract AID/NE-C-1202
by
Harza Overseas Engineering Company
October 1976

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HARZA ENGINEERING COMPANY CONSULTING ENGINEERS

October 22, 1976

Mr. Richard Perry
Agency for International Development
NE/CD
Washington, D.C. 20523

Subject: Kajakai Service Area Power Market Study
Final Draft Report, Phase I - Power Market Survey

Dear Mr. Perry:

We are pleased to submit the Final Draft Report for Phase I, Power Market Survey, of the Kajakai Power Market Study. This Report includes our evaluation of the electric power requirements of the Helmand-Arghandab Valleys. The Interim Field Report upon which this draft report is based was submitted to the AID/Mission-Kabul on May 31, 1976.

The forecast of electrical requirements is based upon economic and technical analysis of results of a field survey of existing and potential consumers in the Helmand-Arghandab Valleys and the City of Jalalabad and data and other information furnished by the Boghra, Kandahar and Nangarhar Breshnas, Water and Power Authority (WAPA), AID/Mission-Kabul and other organizations. We deeply appreciate the assistance and cooperation we received from personnel of all of these agencies. In particular, we are grateful to the Helmand-Arghandab Valley Authority (HAVA) for making it possible for us to include our survey of the rural areas in their current Farm Economic Survey.

Demand and consumption of electric energy in the Kandahar area has been severely depressed for many years due to lack of generating capacity and the high tariff rate, particularly with respect to other areas of Afghanistan. In recent years, the Boghra Breshna has also experienced lack of generating capacity during the four cold months of the year. While demand was necessarily suppressed during these four months, the overall effect of rationing on annual consumption was slight.

The shortage of generating capacity resulted in a distortion of historic consumption and demand patterns. To overcome this problem, Jalalabad (Nangarhar Breshna) where an adequate supply of electric energy has been available for a number of years was selected as a correlation area. Demand and consumption data were obtained from the Breshna and a sample survey of consumers was made using the same questionnaire as for the town residents in the Kandahar and Boghra Breshnas. There was sufficient correlation of the residential, bazaar and commercial customers between the Nangarhar and Boghra Breshnas to give confidence that trends

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developed from the data could be applied to Kandahar where the climate and economic base are nearly identical to that of the Boghra Breshna service area.

The economic analysis of consumers in presently electrified areas and in the nonelectrified farm areas considered family income; source, type and cost of energy forms presently consumed; and level of interest in obtaining and utilizing electric energy. The willingness to pay for electric energy, including the connection cost amortized over a five-year period was determined to be 5.5% of the average total net farm family income (NFFI). This compares with an average of 6.5% for rural consumer expenditures for "fuel and light" in India and Pakistan. Nonelectrified families in urban areas were spending 11.5% of their family annual income for fuel and light versus 12.6% for those with electricity, with about two thirds of this expended for wood and kerosene.

Immediately prior to the Harza Phase I Team's departure from Afghanistan, they were informed by Engineer Fakoor, Director of Planning for WAPA that the load data for the new cement plant in Kandahar furnished to Harza by WAPA was not high enough. He informed the team that he would obtain corrected data for our Resident Manager. As yet we have not received this. Harza's Resident Manager was able to obtain the name of the apparent low bidder for the cement plant, however, and our Chicago Office has been in contact with the Company in an attempt to obtain load and consumption data. If information is received that would have a significant impact on the forecasted loads, corrections will be made in the Final Report.

A rapid surge in electric demand and consumption is anticipated in the Kandahar Breshna following the availability of the Kajakai Hydro Plant power in early 1977 (1356) and the lower tariff expected to then be in effect. It is also anticipated that industrial and commercial concerns presently supplying all or part of their electric requirements with their own generation will then obtain all their requirements from the Breshnas as well as several new industries planned for the area.

It is projected that the peak demand of the Kajakai Service Area will increase from 4,500 kW in 1354 (1975) to 34,000 kW in 1359 (1980); 50,000 kW in 1364 (1985); and 65,000 kW in 1369 (1990). The energy requirements are 21,677 MWh; 142,000 MWh; 217,500 MWh; and 278,500 MWh respectively. These high growth rates will be achieved if the new industrial loads develop, the existing industrial and commercial consumers supplying all or a part of their own electrical requirements convert to obtain all their electric energy

needs from the Breshnas and distribution systems are extended into areas not presently having electric service.

The analysis and conclusions resulting from our study are discussed in detail in Sections III and IV of this Report. Section II contains a summary of these two sections.

Yours very truly,

Donald H. Sandell

Donald H. Sandell
Project Director

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SECTION I

INTRODUCTION

Section I

INTRODUCTION

This Phase I Draft Report is submitted in accordance with the requirements of Paragraph I-B-3-b of Agency for International Development (A.I.D.) Contract No. AID/NE-C-1202, Kajakai Service Area Power Market Study, dated December 15, 1975.

The Study was implemented with the arrival in Afghanistan of Harza Overseas Engineering Company's Resident Manager on January 22, 1976, followed by the Power Market Analyst and Agricultural Economist on February 19, 1976 and the Survey Engineer on March 1, 1976. The office was established in Lashkar Gah with supplemental office facilities in Kabul and Kandahar.

Meetings were held with officials of several local and international agencies, including United Nations Development Program, (UNDP), International Monetary Fund, (IMF), United States Agency for International Development, (USAID), US Embassy, International Bank for Reconstruction and Development (IBRD), Ministry of Mines and Industry, Ministry of Planning, and WAPA to obtain general background information on economics and developments in Afghanistan as well as to obtain prior relevant reports and studies available from these agencies.

As a result of these meetings and reviews of previous studies, the Kajakai Service Area was established and determined to include several non-electrified rural areas in the Helmand and Argandab River Valleys: a) the cultivated areas extending from both banks of the Helmand River from the vicinity of the village of Deshu near the Nimroz (Chakansur) - Helmand Province line, northeasterly to Kajakai Dam; b) the cultivated areas of Nauzad and Musa Qala on two major tributaries to the Helmand River downstream from Kajakai Dam; and c) the cultivated areas along the Arghandab, Dori, and Tarnak Rivers. The Kajakai Service Area also includes a number of partly electrified cities and villages within or contiguous to these rural areas including Kandahar, Lashkar Gah (Bost), Girishk, Nadi Ali, Marja, Chah-I-Anjir, and Bolan Farm. (Exhibit I).

Kandahar consumers receive their electric power from small hydro and diesel plants under the administration of the Kandahar Breshna. Consumers in all other presently electrified cities and villages receive power under the administration of the Boghra Breshna through primary and secondary distribution feeders radiating from substations connected to a 44 kv transmission system supplied by the Girishk Hydel Power Station at Boghra Dam.

Upon the completion of the construction of 210 km of 110 kv transmission line and stepdown stations at Lashkar Gah and Kandahar, the Boghra Breshna and Kandahar Breshna will receive power from the Kajakai Hydro Station, which, though in service, now only supplies power to its operators' colony. (Exhibit II). The ratings of the two hydraulic turbines at Kajakai yield a combined nameplate capacity of 33 mw. Prior to this study, others have determined that the firm peak hourly capability of this plant is 22 mw.

The firm capacity of Kajakai is 17.5 mw greater than the peak loads sustained by the Boghra Breshna (2.3 mw) and Kandahar Breshna (2.2 mw) through the end of 1354 (1975). Load shedding and power rationing were in effect, however, on both systems during the peak load periods in 1354 as has been necessary for many years prior to 1354.

The chronic shortage of electric power in the Kajakai Service Area coupled with a retail cost three times that charged in many other electrified areas of Afghanistan, has undoubtedly severely hindered growth in the power market, both in the number of new consumers connected and annual usage of electrical energy by existing consumers. "Normal" demand for power and "normal" growth of electrical energy usage has probably been further distorted by an understandable reluctance on the part of many potential, full-service consumers to invest in a connection to the systems or retire privately owned auxilliary generating units until a virtually perpetual source of cheap and reliable energy is assured.

Questionnaires developed for use in the field survey of urban and rural districts of the Kajakai Service Area to obtain information from selective samples of existing and potential electricity consumers, are shown in Exhibits III, IV and V.

Statistical operating and accounting data was also collected from the Boghra Breshna and Kandahar Breshna and

analyzed to determine if historical growth trends existed. Because of the drastic rationing of electric power on the Kandahar Breshna system almost entirely since the commissioning of the first generating units in this area; and because of curtailments of power supply to the Boghra Breshna consumers during several months of each of the past four years, the statistics did not provide a secure base for trend analysis and extrapolation, although definite growth trends are evident on the Boghra Breshna system from 1344 (1965) through 1350 (1971).

Correlation methodology was therefore utilized to factor the protracted suppression of load growth in Kandahar and the more recently inhibited growth and expansion of the power market in the Boghra Breshna area. The city of Jalalabad, Afghanistan was chosen as a relevant urban area to use as a power market comparison with the project area. A survey was made of a random sample of electrified town consumers using the same questionnaire as used in the canvass of town consumers in the Boghra Breshna and Kandahar Breshna. Historical operating and accounting data were also obtained from the local administrative organization, the Nangarhar Breshna.

Projections of load growth have been made for the Boghra Breshna and Kandahar Breshna through applications of the results of the Jalalabad survey.

Projections of potential load growth in presently non-electrified rural areas were made primarily on the basis of the potential consumer's willingness and ability to purchase electric power as an alternate to the type of energy for which he now labors directly or purchases with earnings to meet his daily needs.

SECTION II

SUMMARY

Section II

SUMMARY

General

The Kajakai Service Area, with an urban population of approximately 200,000 people, receives its electric energy from the Kandahar and Boghra Breshnas. The two Breshnas serve a combined total of approximately 9,600 metered customers plus an unknown number of unmetered and unbilled customers. The economic base of the area is predominantly agricultural; however, several industries exist such as the Cotton Plant, Marble Factory and Cement Plant.

A severe shortage of electric power available has existed for many years, particularly in the Kandahar Breshna. The distribution system has not been expanded since 1970, and this coupled with the shortage of power, has been a deterrent to the addition of new customers. Industrial and commercial customers who must have a reliable and sufficient source of power have installed their own diesel generation to supply all or a portion of their requirements.

Forecast of Electric Requirements

Data on existing customers is quite limited and in the Kandahar Breshna with rationing for so many years, meaningful, valid data does not exist. The Nangarhar Breshna (Jalalabad) was surveyed and found to correlate in many respects with the Boghra Breshna. The Kandahar Breshna Service Area has an economic base very similar to the Boghra Breshna Service Area; and with the correlation between the Nangarhar and Boghra Breshnas, there is sufficient confidence that the consumption and demand patterns of the Boghra Breshna can be used in projecting consumption and demands for the Kandahar Breshna.

The economic and financial evaluation is divided into three parts: (1) A projection of potential electrical energy demands of the presently non-electrified farm population in the Upper Helmand and Arghandab Valleys; (2) A financial evaluation of the farm and town family's income, energy costs and ability to pay for electricity: and (3) A projection of the town (residential) electrical energy demands using income and energy use relationships of an area (Jalalabad) with an unrestricted supply.

The projection of electrical energy consumption of the farm population considered farm income and cost of existing energy sources as well as the electrical energy use and cost data of presently electrified areas. The impact of price on the total quantity demanded was estimated by setting the Kwh cost at 1 and 3 Afs. In the Helmand and Arghandab Valleys the rural consumption projections are summarized as follows:

	Helmand		Arghandab		Total	
Year	1 Afs	3 Afs	1 Afs	3 Afs	1 Afs	3 Afs
1980	11,647	4,885	2,766	1,145	14,413	6,030
1985	22,379	8,182	5,095	1,849	27,474	10,031
1990	31,369	19,475	7,119	4,414	38,488	23,889

Survey information on town family income and energy costs was used to assess the present energy costs for both electrified and non-electrified families. For non-electrified families, total energy costs averaged 11 percent of family income, which is significantly higher than that incurred by farm families (3.7 percent). A greater reliance of town families on purchased supplies contributed to the difference. Electrified town families continued to have relatively high total energy cost which averaged 12.6 percent of family income. A signficant portion of the cost was for non-electrical energy, accounting for 68 percent of the total cost. The non-electrified town families expressed a desire for electricity and indicated a willingness to (1) pay an average of 2,100 Afs for connection costs and (2) pay 253 Afs monthly or 3,030 Afs annual for electricity, representing 6.7 percent of the average family income for the three towns surveyed - Lashkar Gah, Girishk, and Kandahar.

The farm families indicated a willingness to (1) pay an average of 3,400 Afs. for connection costs and (2) pay 131 Afs. monthly or 1,572 Afs. annually for electricity, representing 3.5 percent of the average income of the families surveyed in the Upper Helmand Valley demand areas "B" and "C" (See Exhibit I). The present cash cost of non-electrical energy sources was relatively low for the farm families due to number of families that are self-suppliers.

The projection of town (residential) electrical energy demands using income and energy use relationships produced approximately the same total energy estimates for 1369 (1990) as the trend analysis adjusted for the effects of

rationing. For the 1354-1364 period the economic forecasts were lower than the trend analysis which adjusts for consumption experience under restricted supply conditions. Both projections support similar system capacity requirements to serve the town residential load for the larget year 1369 (1990).

Government repayment policies will require careful assessment of the cost of service to the lower income groups. Financial assistance to meet the cost for connection and wiring should be considered when rate schedules are proposed.

The forecasts of customers, energy requirements and electrical demand for the entire Kajakai Service Area summarized below are shown in detail in Table II-1 at the end of this Section. Table II-2 and II-3 show the same information for the Boghra and Kandahar Breshnas respectively.

Year	Number of Customers	Energy Requirements MWH	Demand KW
1354 (1975)	9,571	21,677	4,500
1359 (1980)	24,385	142,000	34,000
1364 (1985)	34,310	217,500	50,000
1369 (1990)	52,463	278,500	65,000

From the above table, the rapid growth anticipated immediately following the availability of the Kajakai Hydro Power is readily discernable. In the five year period 1354-1359, the number of customers is expected to grow from 9,571 to 24,385 or 255 percent; the energy requirements from 21,677 to 142,000 megawatt-hours or 655 percent; and the electrical demand from 4,500 to 34,000 kilowatts, 756 percent. This very high growth rate in energy requirements and electrical demand results from the elimination of rationing, new industrial loads already planned for the area and furnishing the complete requirements to consumers presently supplying all or a portion of their energy requirements with privately owned generating facilities.

Conclusions

To achieve the projected increases, the following must be accomplished:

1. Distribution systems in the presently electrified areas must be expanded to serve customers desiring electrical service.

2. Distribution systems must be constructed in those areas presently not electrified where there is sufficient customer potential. Electrification of the rural areas in the Upper Helmand Valley should be accomplished in a staged expansion program with the initial phases encompassing those areas defined as Area B and Area C.

3. Industrial loads presently planned must become a reality.

4. Customers supplying all or a portion of their electrical requirements must obtain all of their requirements from the Breshnas.

5. Financial assistance should be provided for lower income families for the connection and wiring costs. (WAPA indicated that this is presently under consideration).

6. If the firm capacity of existing generation in the Helmand and Arghandab Valleys remains at 4,500 KW, the addition of 22,000 KW of firm capacity at Kajakai provides a total of 26,500 KW. If the projected growth rates are achieved, the firm capacity rating will be exceeded by the year 1358 (1979).

7. Systems and procedures must be established to collect and analyze customer data, system loads and other technical data necessary for preparing adequate load forecasts, and for planning expansion of existing facilities.

Table II-1

FORECAST OF ELECTRICAL REQUIREMENTS
KAJAKAI SERVICE AREA

Customers

Class of Customer	YEAR 1354 (1975)	1359 (1980)	1364 (1985)	1369 (1990)
Rural (Farm)	0	8,426	11,390	22,780
Residential	7,169	12,480	18,340	24,030
Bazaar	1,994	2,875	3,760	4,625
Commercial	390	580	790	990
Industrial	18	24	30	38
Total	9,571	24,385	34,310	52,463

Energy Requirements - MWh

Class of Customer	YEAR 1354 (1975)	1359 (1980)	1364 (1985)	1369 (1990)
Rural (Farm) 1/	0	6,000	10,000	24,000
Residential 2/	8,683	31,300	41,400	48,000
Bazaar	1,497	4,800	7,000	9,000
Commercial	4,499	19,000	24,000	30,000
Industrial	1,334	67,000	121,000	152,500
Losses 3/	5,664	13,900	14,100	15,000
Total	21,677	142,000	217,500	278,500

Electrical Demand - kW

Class of Customer	YEAR 1354 (1975)	1359 (1980)	1364 (1985)	1369 (1990)
Rural (Farm)	0	2,000	3,500	8,000
Residential	1,500	8,600	11,400	13,300
Bazaar	400	1,450	2,150	2,750
Commercial	1,200	5,700	7,100	8,900
Industrial	100	12,500	22,000	28,000
Losses 3/	1,300	3,750	3,850	4,050
Total	4,500	34,000	50,000	65,000

1/ Rural demand based on the 3 Afs. per kWh rate.

2/ Residential demand based on the adjusted trend projections developed in Section III.

3/ Losses include system losses plus non-metered consumption.

Table II-2

FORECAST OF ELECTRICAL REQUIREMENTS
BOGHRA BRESHNA

Customers

Class of Customer	1354 (1975)	1359 (1980)	1364 (1985)	1369 (1990)
Residential	1,444	2,180	3,040	4,030
Bazaar	319	450	590	725
Commercial	65	95	130	160
Industrial	1	2	4	6
Total	1,829	2,727	3,764	4,921

Energy Requirements - MWh

Class of Customer	1354 (1975)	1359 (1980)	1364 (1985)	1369 (1990)
Residential	3,683	5,300	6,800	8,000
Bazaar	497	800	1,100	1,400
Commercial	2,499	3,000	3,900	4,800
Industrial	890	11,000	17,800	26,400
Losses 1/	2,664	2,300	2,400	2,400
Total	10,233	22,400	32,000	43,000

Electrical Demand - kW

Class of Customer	YEAR 1354 (1975)	1359 (1980)	1364 (1985)	1369 (1990)
Residential	900	1,500	1,900	2,300
Bazaar	100	250	350	450
Commercial	600	900	1,100	1,400
Industrial	0	1,800	2,800	4,500
Losses 1/	700	650	650	650
Total	2,300	5,100	6,800	9,300

1/ Losses include system losses plus non-metered consumption.

Table II-3

FORECAST OF ELECTRICAL REQUIREMENTS
KANDAHAR BRESHNA

Customers

Class of Customer	YEAR 1354 (1975)	1359 (1980)	1364 (1935)	1369 (1990)
Residential	5,725	10,300	15,300	20,000
Bazaar	1,675	2,425	3,170	3,900
Commercial	325	485	660	830
Industrial	17	22	26	32
Total	7,743	13,232	19,156	24,762

Energy Requirements - MWh

Class of Customer	YEAR 1354 (1975)	1359 (1980)	1364 (1935)	1369 (1990)
Residential	5,000	26,000	34,600	40,000
Bazaar	1,000	4,000	5,900	7,600
Commercial	2,000	16,000	20,100	25,200
Industrial	444	56,000	103,200	126,200
Losses 1/	3,000	11,500	11,700	12,500
Total	11,444	113,500	175,500	211,500

Electrical Demand - KW

Class of Customer	YEAR 1354 (1975)	1359 (1980)	1364 (1985)	1369 (1990)
Residential	600	7,100	9,500	11,000
Bazaar	300	1,200	1,800	2,300
Commercial	600	4,800	6,000	7,500
Industrial	100	10,700	19,200	23,500
Losses 1/	600	3,100	3,200	3,400
Total	2,200	26,900	43,000	47,700

1/ Losses include system losses plus non-metered consumption.

SECTION III

FORECAST OF ELECTRICAL REQUIREMENTS

SECTION III

FORECAST OF ELECTRICAL REQUIREMENTS

Existing Electric Power Facilities in the Kajakai Service Area

Two isolated electric systems are in operation in the Kajakai Service Area, the Kandahar Breshna and the Boghra Breshna. Both are agencies of the Water and Power Authority responsible for the supply of electric service to a combined total of 200,000 inhabitants of the cities, villages and rural areas within their jurisdictions.

The Kandahar Breshna presently supplies electric service to over 7,700 metered consumers of the Arghandab Valley in the city of Kandahar, the Kandahar International Airport 20 km to the southeast, and the Mirwais Maina Housing Development seven km west of Kandahar. Power is generated in a diesel station in Kandahar and two small irrigation canal hydro stations, Baba Wali and Filkoh, seven km and four km northwest of Kandahar. A primary voltage of 3.3 kV is used for distributing power within the city limits. Extensions to the Kandahar airport and the housing development outside the city limits are operating at 13.2 kV.

Both single phase and three-phase distribution transformer installations are in service in Kandahar serving a variety of secondary system voltages: 120/240V, single-phase; 120/208V, two and three-phase; 220 volt single phase; and 220/380V three phase.

Many individual consumers of the Kandahar Breshna are unmetered in accordance with government policy, and in addition to this unmetered consumption, numerous illegal, unmeterd connections are reported to exist.

The Boghra Breshna system serves 6 electrified villages and towns in the Helmand Valley with a combined total of over 1,800 metered consumers: Lashkar Gah, Bolan Farm, Marja, Nad-I-Ali, Chah-I-Anjir and Girishk. Power is supplied to the Bogra Breshna system from the Girishk Hydroelectric Powerplant located on the Boghra Canal 2.5 km northeast of the town of Girishk and consists of two 1,500 kVa units with a firm capability of 2,300 kW. Power is generated at 3.3 kV and stepped up to 44 kV through 3-1,000 kVa single

phase transformers. A 44 kV transmission system of approximately 75 km of #2 ACSR, single-circuit, pin insulator, steel-pole line delivers power to the six 44/3.3 kV substations of the Boghra Breshna.

Primary circuits in the villages operate at 3.3 kV, and as in the case of Kandahar, both single and three-phase transformer installations serve a mixture of secondary voltages. A large amount of consumer energy is not individually metered because of government policy and reported illegal connections.

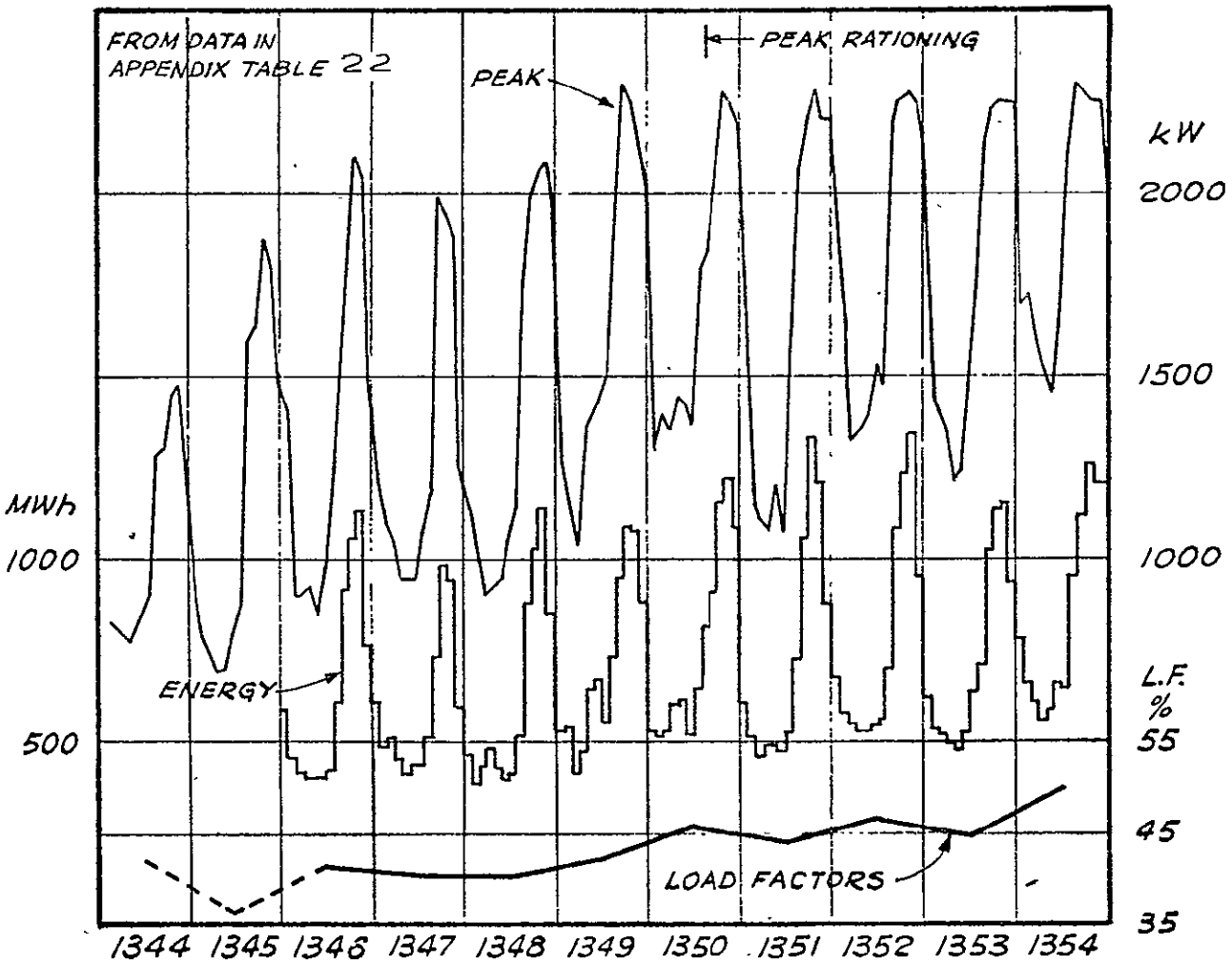
The Kajakai Hydro plant, located 70 km upstream of the Girishk Hydro plant has an installed capacity of 33 MW. However, due to decreased head during certain periods, it has a firm capacity of only 22 MW. Presently, it supplies electric power only to the Operators village adjacent to the plant. Transmission lines to operate at 110 kV are presently under construction that will connect the Kajakai plant to a 110/20 kV substation at Kandahar and a 110/44 kV substation at Lashkar Gah. When these are complete, the system will be as shown on Exhibit II.

The Kandahar Diesel Generating Plant consists of two 1,500 KW units, but because of difficulties, the firm capacity is only 1,500 KW. A severe power shortage has existed in the Kandahar Breshna for a number of years, resulting in commercial and industrial consumers, who must have power for their operations, installing their own generation. The Kandahar Breshna serves four times as many consumers as the Boghra Breshna, yet in 1354, supplied only slightly more energy for these consumers. Rationing has of necessity been very severe, making historic peak demands and energy generation and consumption as invalid basis for determining growth trends or projecting future demands and consumption.

The Girishk Hydro Plant has been capable of supplying the power requirements of the Boghra Breshna until the year 1350 when it became necessary to curtail demand during the peak load hours of the four cold winter months. The monthly peak demands, energy generated and annual load factors of the Girishk Hydro are shown in Figure III-1.

With the availability of an adequate power supply from the Kajakai Hydro plant, a number of new industries are planned for the area in the next five years. In addition, those industrial and commercial customers presently supplying their own electric energy needs will undoubtedly obtain their needs from the Breshnas.

FIGURE III - 1



MAXIMUM MONTHLY PEAK LOADS, MONTHLY ENERGY AS MEASURED AND THE ANNUAL LOAD FACTORS OF THE BOGHRA BRESHNA

Future Loads - Boghra Breshna

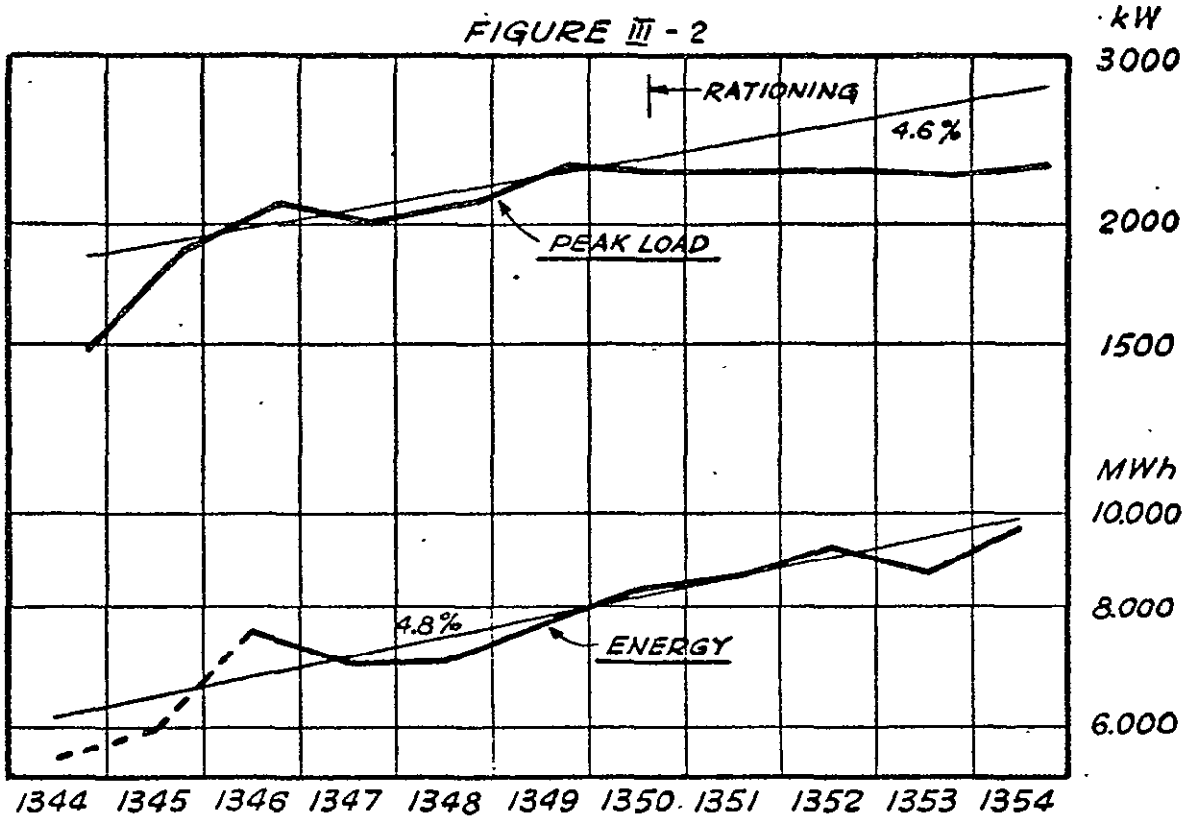
General.

Following the renovation of the Girishk Hydro, the distribution system was rehabilitated and expanded. This work, completed in 1348, was followed by a period of accelerated load growth. However, two years ago there was an exodus of foreign families from the area. These were high energy consumers, which may be one reason for the system load being less than might have been expected in the last two years.

The largest load supplied by the Boghra system and its only true industrial customer is the cotton gin. Associated with the cotton gin operation is a cotton seed oil extraction plant which has its own generation. During heavy load periods on the Boghra system, the gin is also supplied from the extracting plant generation. The energy supplied the cotton processes by the Boghra system has varied widely from year to year. Because of this erratic usage it is desirable to investigate the system growth characteristics, with the energy supplied to cotton gin excluded.

The majority of the customers have been rationed since the year 1350. Load reduction in the early rationing years were minimal, but at the maximum last winter, a customer could expect to be without power every sixth day for three hours from six o'clock in the morning, and again for four hours after six in the evening. In the early and late parts of the winter when the load was lighter, the hours of rationing were shorter. No customer was without electric service for more than approximately 100 hours last year due to rationing. With this type of load reduction the annual energy consumption was probably not reduced by more than 3% in 1354.

FIGURE III - 2



BOGHRA BRESHNA MEASURED PEAK LOADS AND THE ENERGY LOADS ADJUSTED FOR THE EFFECT OF RATIONING AND WITH THE COTTON GIN LOAD EXCLUDED

The peak load data of Figure III-2 are the measured annual kilowatt demands. The cotton gin energy has been deducted from the measured energy loads and the resulting load has been adjusted for the estimated effect of the rationing of the past five years.

Trend lines have been placed on the kilowatt and kilowatt hour curves shown in Figure III-2 even though the history is relatively short. Using these, it is possible to estimate what the loads in the Boghra Breshna might have been last year had there been sufficient generating capacity and the Cotton Company had taken all its power needs from the system:

	Peak kW	Energy kWh
From the curves of Figure III-2	2,800	9,900,000
Cotton Gin	300	2,150,000
Cotton Seed Oil Plant	470	3,750,000
Total	3,600	15,800,000

Load Factor 50%

Customer Loads

In all but the four cold months when the peak loads and energy requirements are less than the capability of the Girishk plant, the Breshna permits the cotton gin to take its requirements from the system. Even after that, there remains capability to serve more load. As a result, the utility has been anxious to connect new customers for the added revenue they would contribute. They have, however, been limited in this endeavor by lack of money to expand the distribution system which has not been increased to any extent since the rehabilitation program was completed at the end of 1348. Potential consumers within the distribution range of the existing 220 volt secondaries and that could be connected with the minimum of material have been provided service, resulting in a continuous growth in the number of customers of all classes.

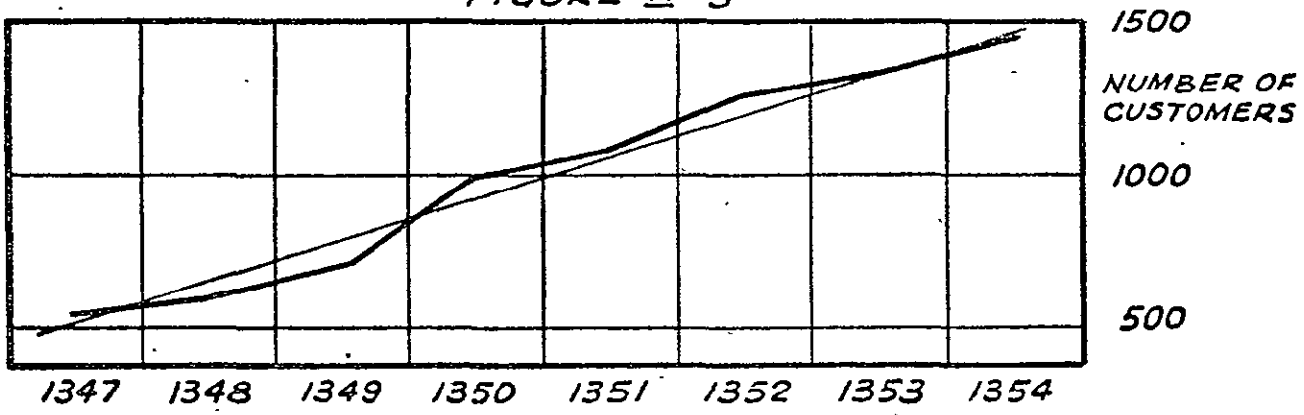
The energy consumption of the customers in the recent past has been reduced by the rationing. In the curves that follow, the actual use by the various classes of consumer

has been adjusted for these load reductions. The rationing schedules, quite logically, were arranged so that the residential customers were most affected. In deriving the annual energy used per customer it has been assumed that 80% of the estimated kilowatt hours lost through rationing was from the residential loads with 10% from the bazaars and a similar amount from the commercial sector.

Residential

The number of residential customers has been increasing more or less linearly for the past seven years as shown below on Figure III-3. (Detail data for Figures III-3 to III-9 are given on Appendix Table 23).

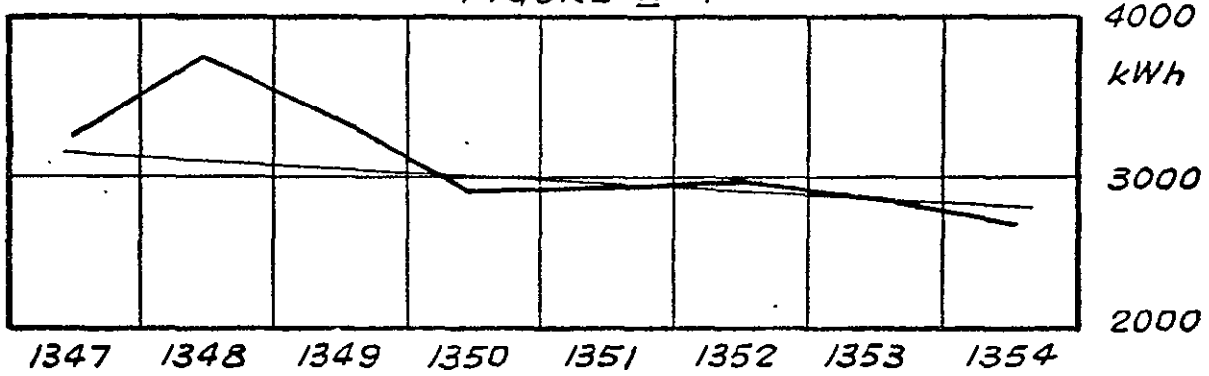
FIGURE III-3



GROWTH IN THE NUMBER OF BOGHRA BRESHNA RESIDENTIAL CUSTOMERS

While the number of customers has increased in each of the past years, the energy use per customer has been following a downward trend. This should not be a surprise, as the better and larger homes and therefore the high energy consumers, have not been increasing as rapidly as the total number of customers in recent years. The new customers being connected are the households in the less affluent sections of Lashkar Gah and the villages of the service area. They are low energy users and, as the proportion of this type of consumer has increased, the average use per customer has decreased as shown on Figure III-4.

FIGURE III-4



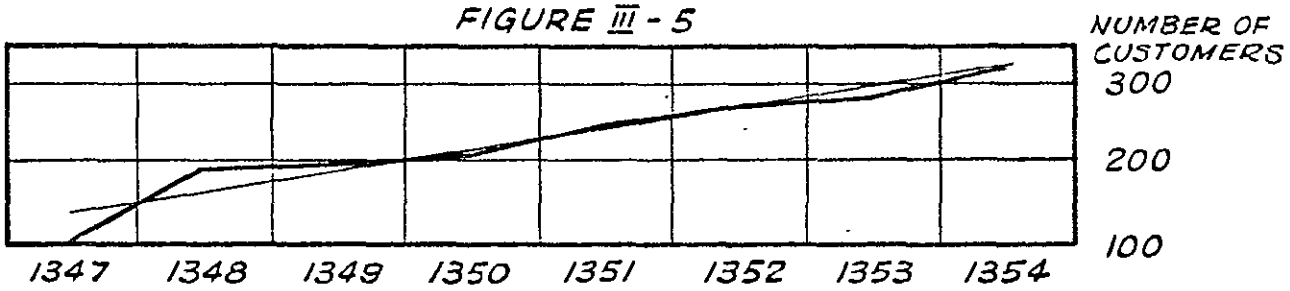
ENERGY USED BY EACH BOGHRA BRESHNA RESIDENTIAL CUSTOMER

Bazaars

The bazaars are the shopping centers of the towns and villages and are generally a discreet geographical area. These consist of all types of retail stores, restaurants, hotels -- places where all the necessities of life can be purchased or made. In a nine block area in Lashkar Gah there are more than 800 separate cubicles where some type of business is transacted; in addition there are also a number of other merchants doing business in the open or under canvas.

Increasing the number of bazaar customers has not had a high priority with the Breshna because the requirement of most is only one or two lights and then used primarily in the short days of the winter months. However, many bazaars must have power and the number with a connection has continously increased as shown in Figure III-5.

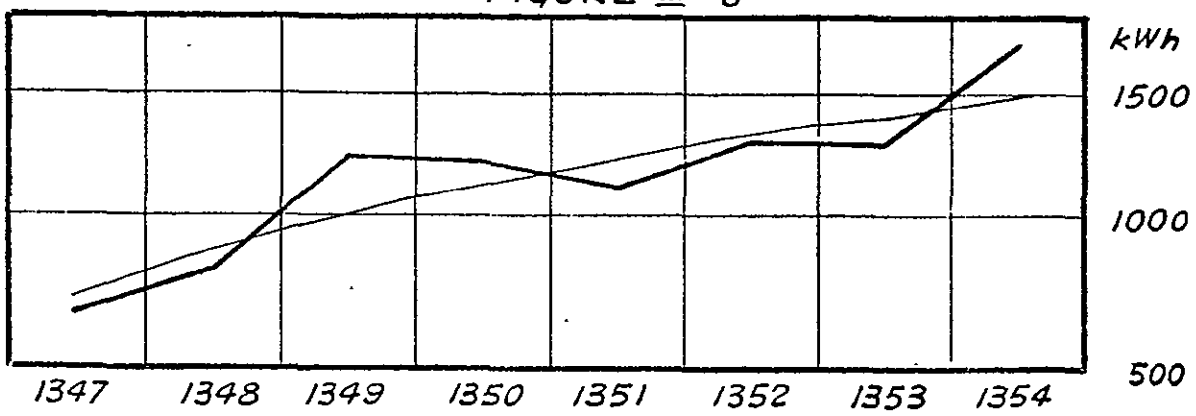
FIGURE III-5



GROWTH IN THE NUMBER OF BOGHRA BRESHNA BAZAAR CUSTOMERS

The energy use by bazaar customers has been following an upward trend as indicated on Figure III-6.

FIGURE III-6

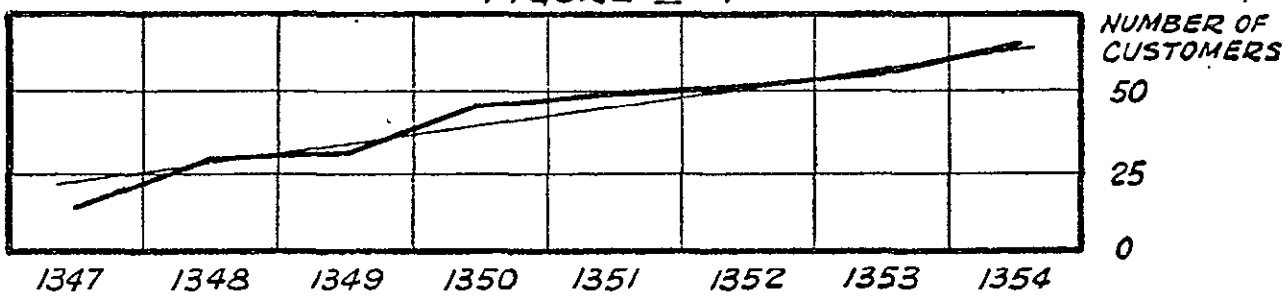


ENERGY USED BY EACH BOGHRA BRESHNA BAZAAR CUSTOMER

Commercial

Every commercial enterprise that must have power for their business and is near enough to the distribution system has an electrical connection. While there are relatively few commercial customers in the Boghra service area, they are increasing each year as shown in Figure III-7.

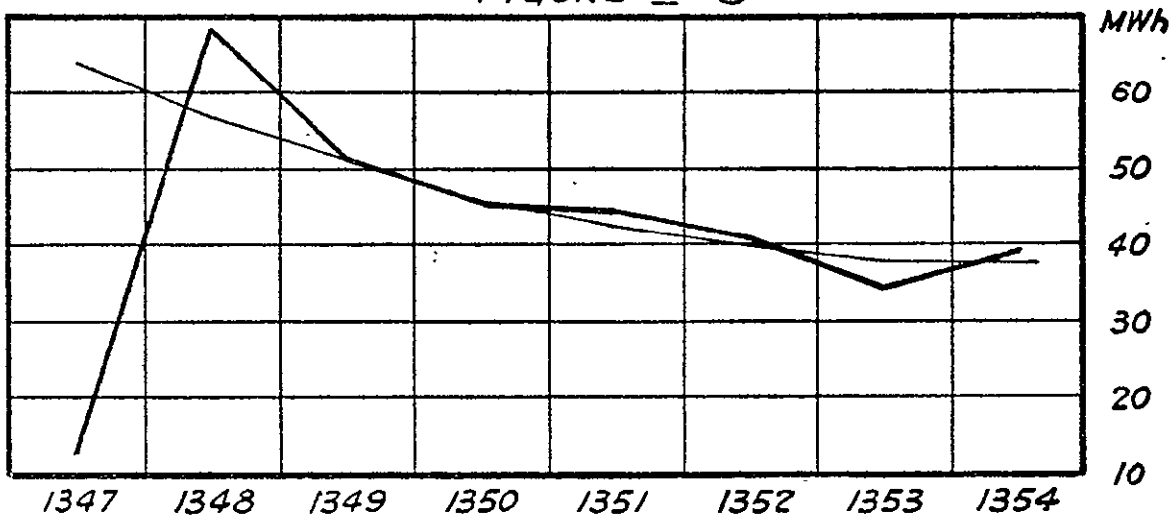
FIGURE III-7



GROWTH IN THE NUMBER OF BOGHRA BRESHNA COMMERCIAL CUSTOMERS

The energy requirement per commercial customer is much larger than for the other classes of consumers, but as the number of commercial customers has increased, the use per customer has decreased as can be seen in Figure III-8. This means that the majority of the new customers use electric energy primarily for lighting.

FIGURE III-8



ENERGY USED BY EACH BOGHRA BRESHNA COMMERCIAL CUSTOMER

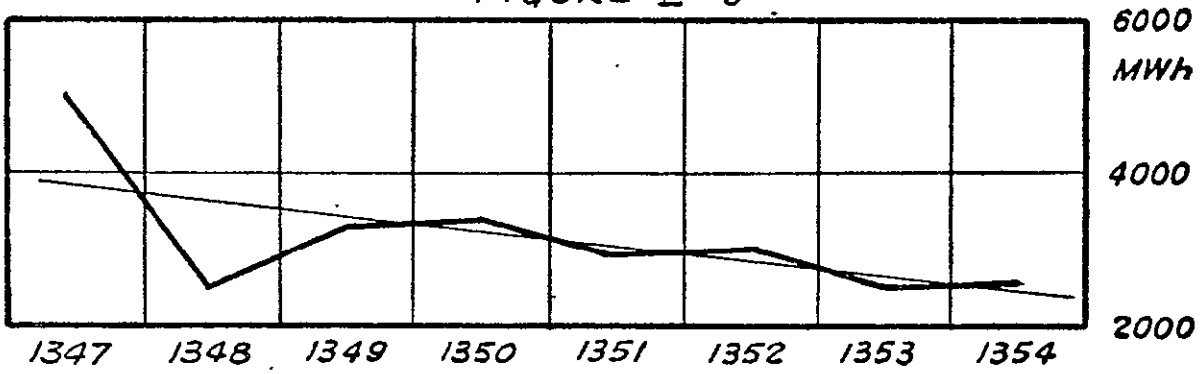
Losses and Unmetered

Almost all the residential and bazaar energy users are said to be metered but street lights, mosques, water pumps, government offices and a few other organizations are not. In addition to the energy for these purposes, there are the electrical losses of transmission, transformation and distribution. The total energy unmetered has been determined by subtracting the metered customer use from the metered generator output. The history of these losses is shown on Figure III-9.

Since 1350 there has been a 22% decrease in the energy not registered on the meters. These years correspond to the rationing periods when the annual peak of the system was constant at the maximum capability of the generating plant

and the load factor didn't vary much from year to year. As the system losses remained constant, the decrease must represent non-metered loads becoming metered loads.

FIGURE III-9



LOSSES AND UNMETERED LOADS IN THE BOGHRA BRESHNA

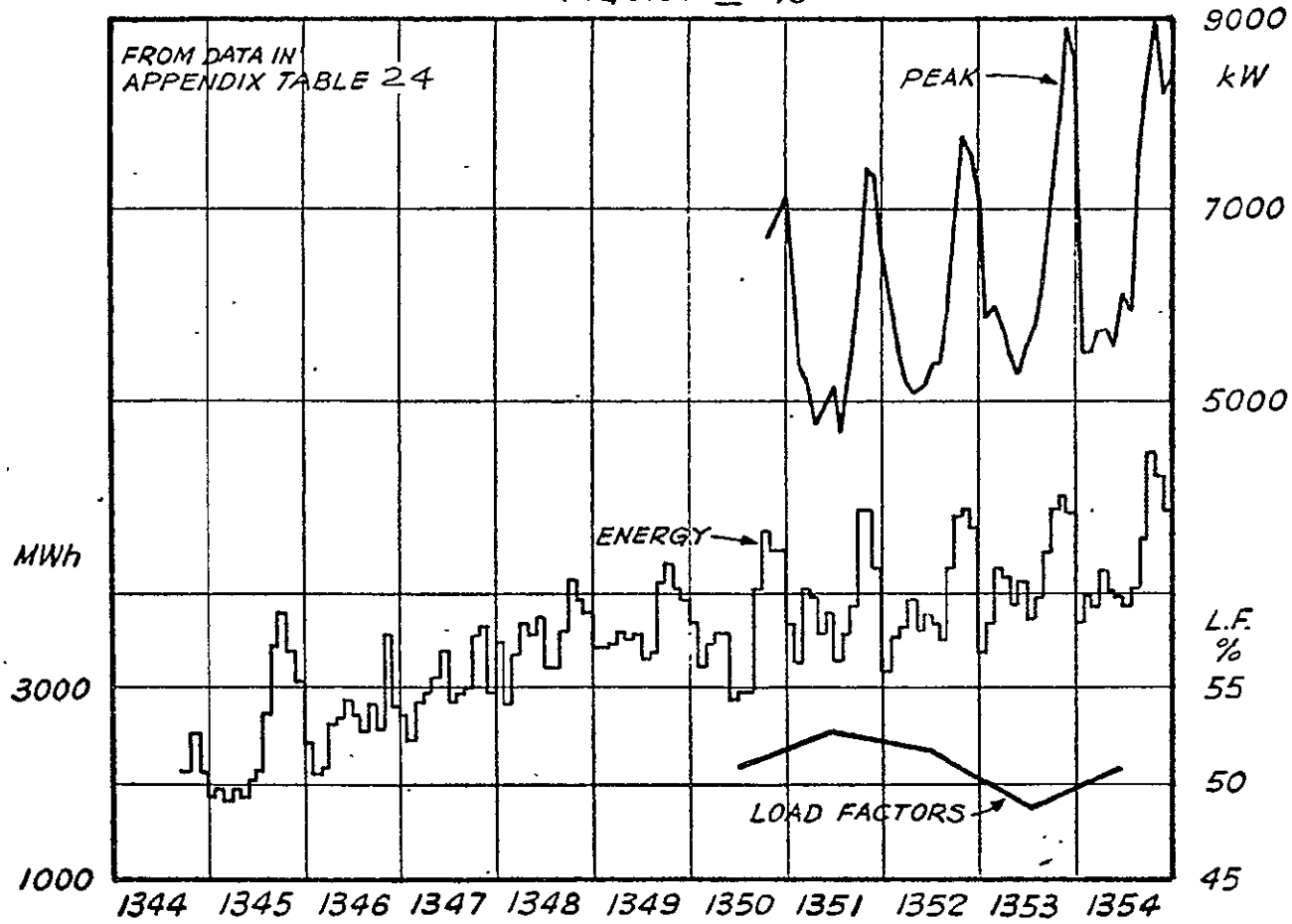
Correlation Area

It was desirable to study the load growth and customer use in an area of Afghanistan where there has been sufficient power to meet all the load demands, and where the price of the energy was the same as that of the Boghra Breshna. The results of this study would serve to verify growth trends in the Boghra Breshna and provide a basis for projecting load and energy uses for the Kandahar Breshna for which no valid statistical data exists.

The Nangarhar Breshna which serves the city of Jalalabad was selected for this purpose. Jalalabad, situated on the flood plain of the Kabul River some 135 km east of Kabul, has had an adequate power source available for the past few years. Data of this system in the years for which the records were available are shown on Figures III-10 and III-11.

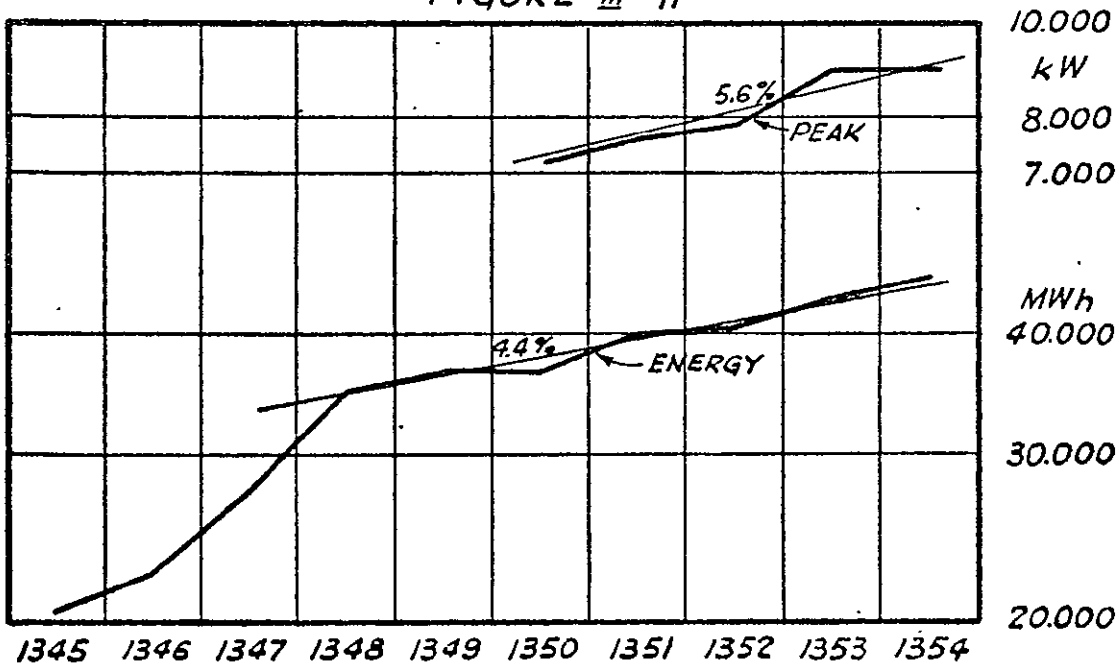
The Nangarhar system has only a few commercial customers and no industrial load, but there are large irrigation pumps supplied from the system, so the growth rates and load factors for these classes of loads are not likely to be the same as for the Helmand - Arghandab Valley. However, the growth patterns in the residential and bazaar areas of Jalalabad can be used for comparisons and the data for this is shown on Appendix Table 25.

FIGURE III-10



MAXIMUM MONTHLY PEAK, MONTHLY ENERGY
AND THE ANNUAL LOAD FACTORS IN THE NANGARHAR BRESHNA

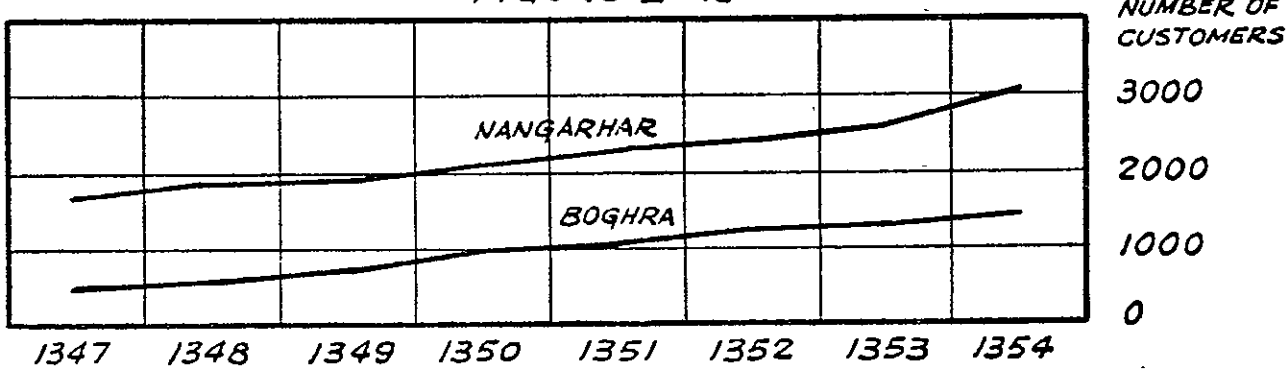
FIGURE III-11



PEAK AND ENERGY LOAD GROWTH OF THE NANGARHAR BRESHNA

The number of residential customers increased over the past nine years in a linear fashion just as in the Boghra system. While there are twice as many customers in the Nangarhar Breshna the rates of increase have been similar in both systems. The historic residential customer growth for both system is shown on Figure III-12.

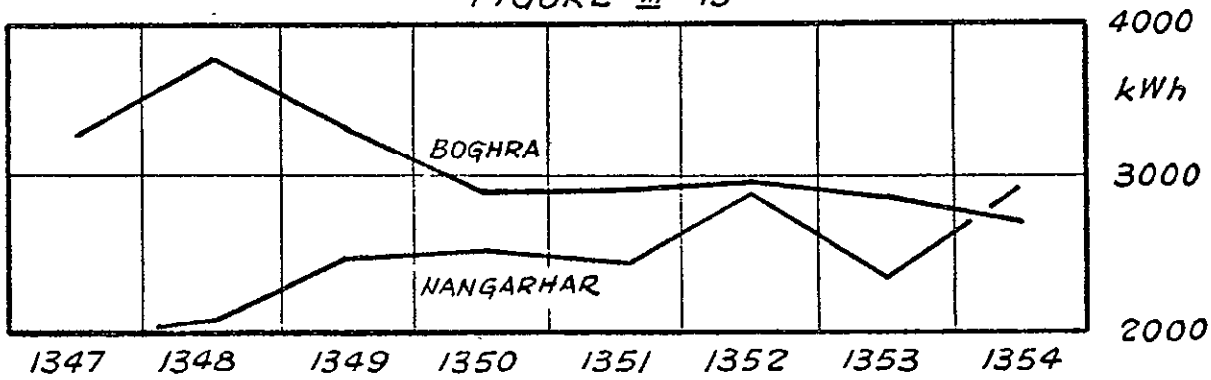
FIGURE III - 12



GROWTH IN THE NUMBER OF BOGHRA AND NANGARHAR BRESHNA RESIDENTIAL CUSTOMERS

Prior to the year 1352 the residential customers of Nangarhar used less energy than this type of consumer in Lashkar Gah. In the past three years the consumption in Jalalabad has been eratic and, last year the average use of residential customers was slightly higher than that in the Helmand Valley. It is not possible to tell if this is an indication that the use per customer is increasing or whether the wide variations were due to some unusual factors. Residential customers use for the past eight years is shown on Figure III-13.

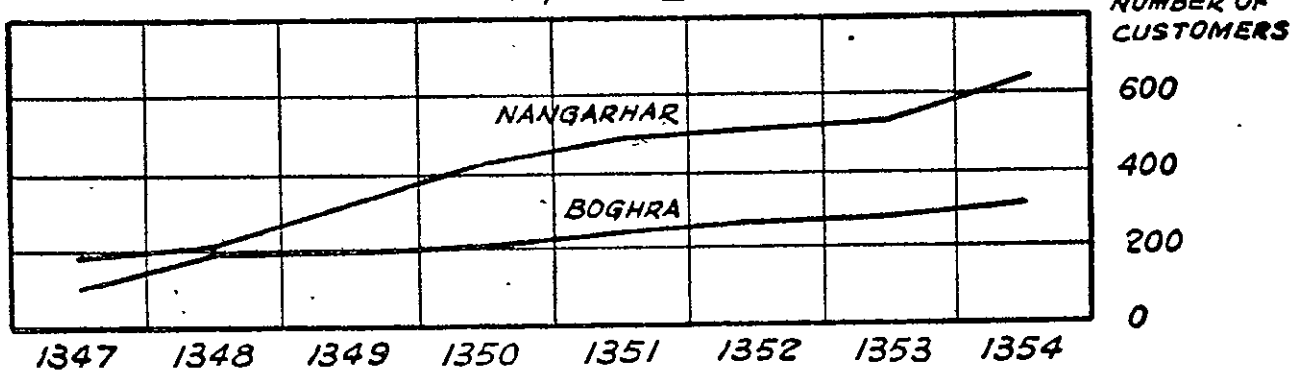
FIGURE III - 13



ENERGY USEL BY EACH RESIDENTIAL CUSTOMER IN THE BOGHRA AND NANGARHAR BRESHNA

While the Nangarhar system serves twice as many bazaar customers as the Boghra system, in recent years they have increased at about the same rate. Figure III-14 shows the growth in bazaar customers for both systems.

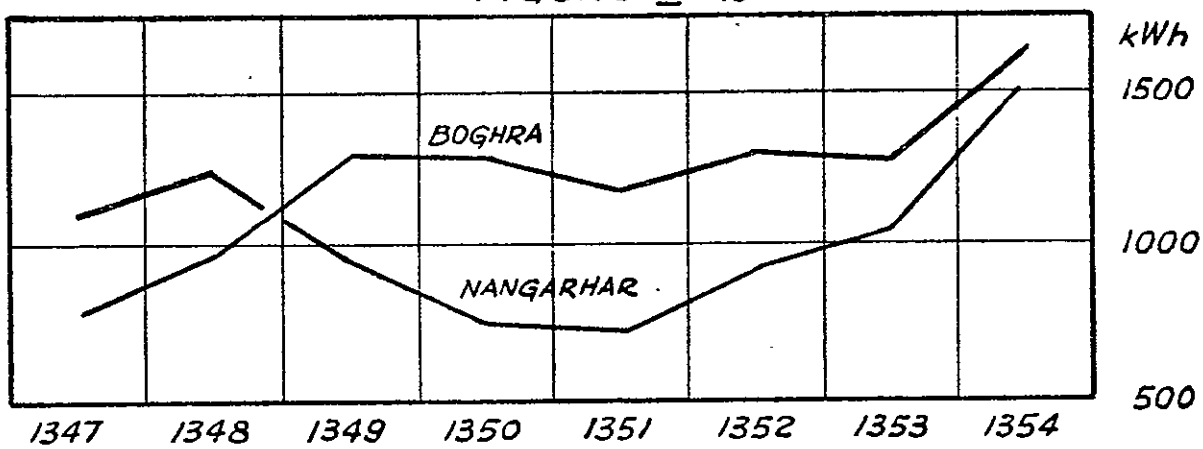
FIGURE III - 14



GROWTH IN THE NUMBER OF BOGHRA AND NANGARHAR BRESHNA BAZAAR CUSTOMERS

Figure III-15 shows the annual use of energy by the average bazaar customer in the two Breshnas. While the usage in Jalalabad has fluctuated considerably, the recent trend in use has been upward just as in the Boghra Breshna.

FIGURE III - 15



ENERGY USED BY EACH BAZAAR CUSTOMER IN THE BOGHRA AND NANGARHAR BRESHNA

The use of energy by the households and bazaars in Jalalabad has in general been a little less than in Lashkar Gah and the surrounding areas. The reason may well be that Jalalabad, besides being an agricultural center is also a winter resort for Kabul residents and therefore has some customers who use energy for only a few months of the year.

System Growth - Boghra Breshna

Since the history of growth in the Boghra service area has identifiable trends, the future energy loads may be estimated by extending the trends of the various classes of consumers into the future.

Residential

There were 1,444 metered residential consumers at the end of 1354, but there were more houses legally receiving energy. One meter on a house on the outskirts of the city often records the energy comsumption of several consumers. In one extreme case it was found that 63 houses were being billed from 16 meters.

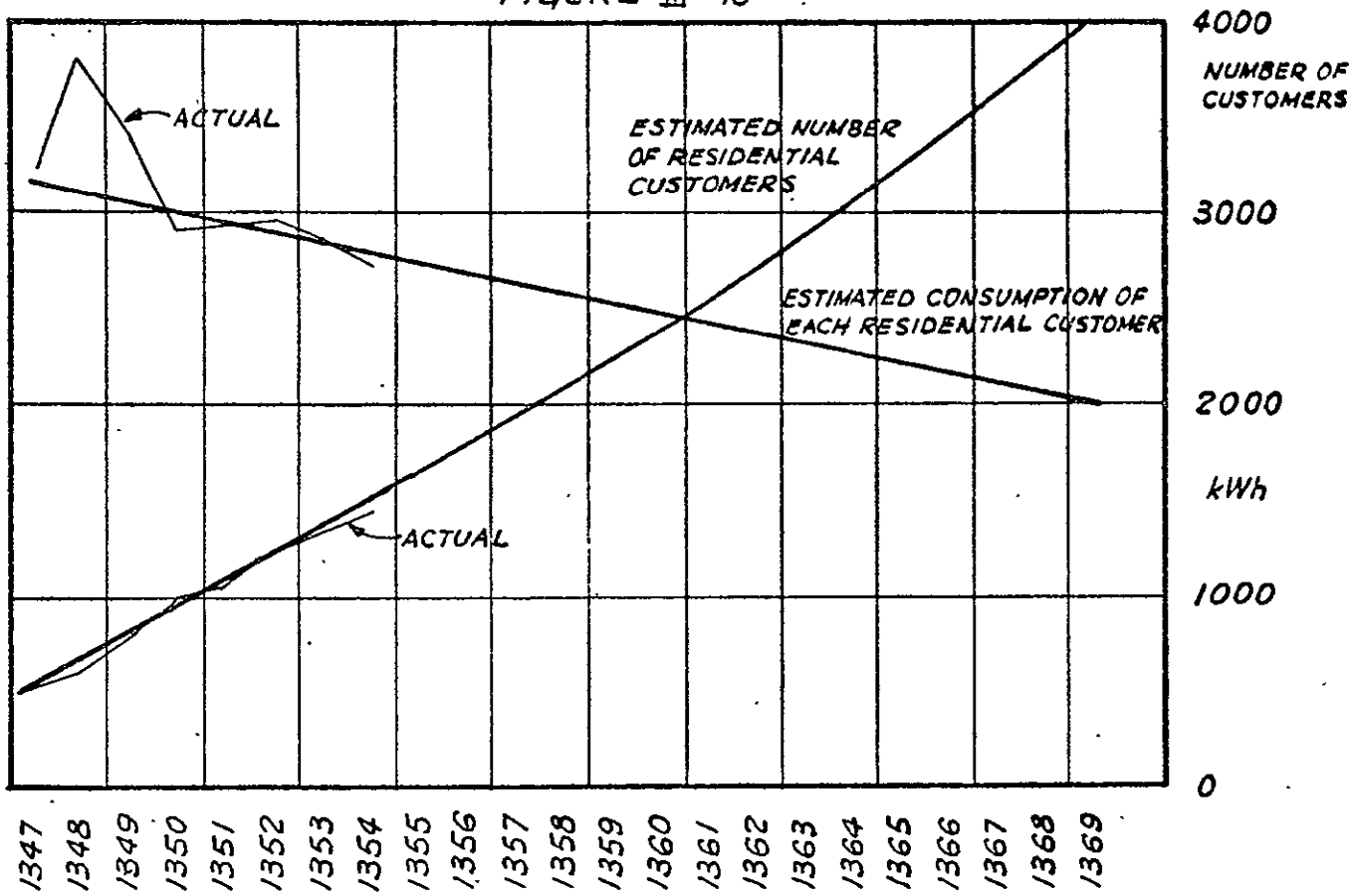
There are many residences within 30 meters of the present secondaries that do not have an electric service; presumably because the owner cannot afford the connection charge and house wiring cost; does not have the money to pay for energy he would consume if he were connected; or has other priorities for his money.

There are approximately 2,500 non-electrified households presently in the Boghra service area, but because some will be unable to afford a connection and others will have their energy needs supplied through a neighbor's meter, all these households will not become customers even after the distribution system has been extended to all the potential customer areas. There will also be new houses constructed. It is assumed that the number of customers will increase at only a slightly greater rate than they have in the past, totalling about 4,000 residential customers in fifteen years.

The energy use per customer has been decreasing over the years and it is assumed that this downward trend will continue as shown in Figure III-16. This conclusion results from projecting the historical data, but other information also supports this conclusion. A random survey, which included energy use, was made of twenty electrified house-

holds in Lashkar Gah, twenty in Girishk and forty in Jalalabad. The average energy use of those surveyed in Lashkar Gah was 1,400 kWh in 1354; in Girishk the average was 800 kWh. The 1,444 metered residences of the Boghra Breshna used 3,683,000 kWh in 1354 or 2,550 kWh per customer. The large difference between the usage of those sampled and the average of all the customers is explained by the fact that the survey did not include the larger houses in the center of Lashkar Gah. This suggests that the use by the consumers to be connected in the future will continue to lower the average use of all the customers. On the other hand, in Jalalabad where no groups were excluded from the survey, the average use of the forty households was only 1,200 kwh in 1354 while the average of all residential customers in the same year was 2940 kwh.

FIGURE III - 16



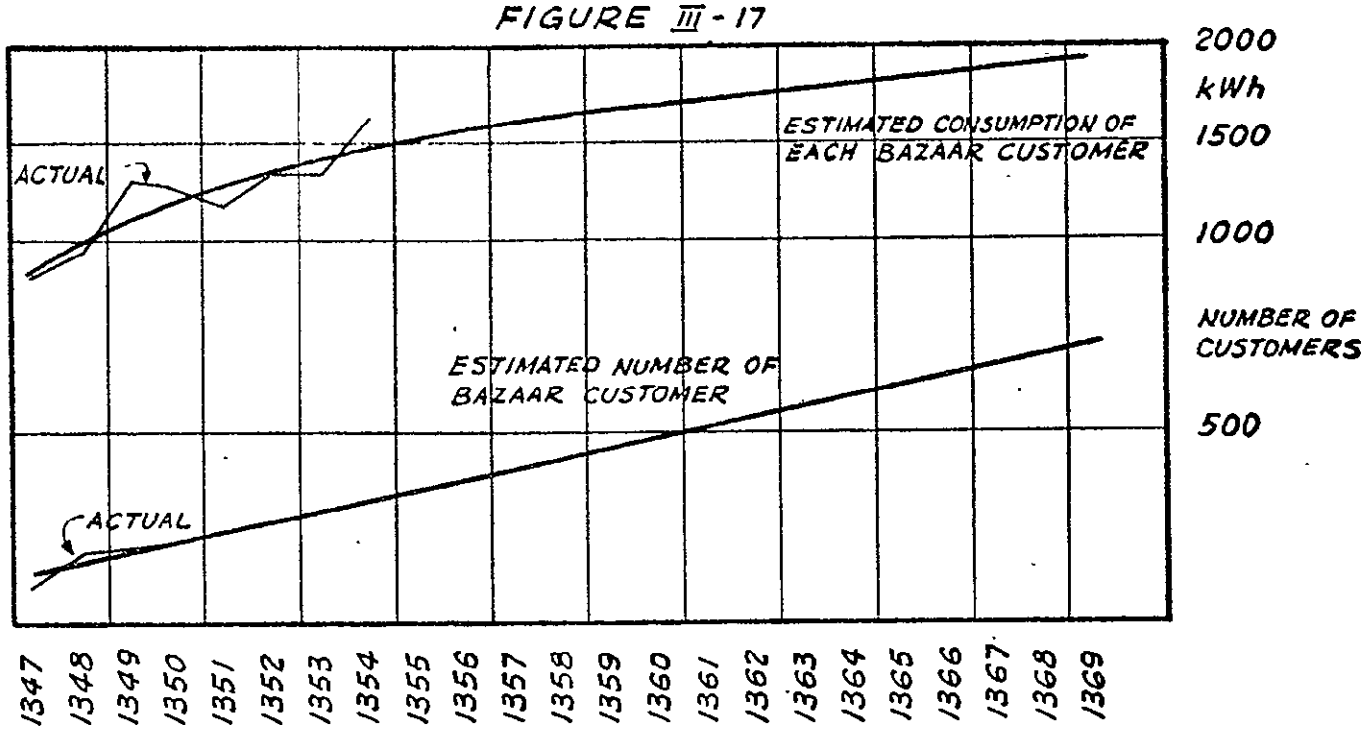
ESTIMATED GROWTH IN THE NUMBER OF BOGHRA BRESHNA RESIDENTIAL CUSTOMERS AND ENERGY CONSUMPTION PER CUSTOMER IN EACH YEAR

Bazaars

On the average only one bazaar cubicle in five has an electric meter but every merchant has the power required to conduct his business. The larger bazaar consumers each have a meter, but those that only use one light, or a light and a heater, or a hot plate, often are supplied from a neighbor's connection. If there were an effort to meter each bazaar operator, the average use of energy per customer would decline because the use of energy by those not now served would be low. This has not been done in Jalalabad, and it is assumed that in the Boghra Breshna customers will continue to be added in the future as they have in the past.

The trend in the use of energy used by bazaars has been increasing and last year it reached 1,650 kWh per customer. It has been assumed that the increase in customer use will continue as indicated on Figure III-17, even though a random survey of forty of these customers showed that their average use was slightly less than 1,000 kWh in 1354.

FIGURE III-17

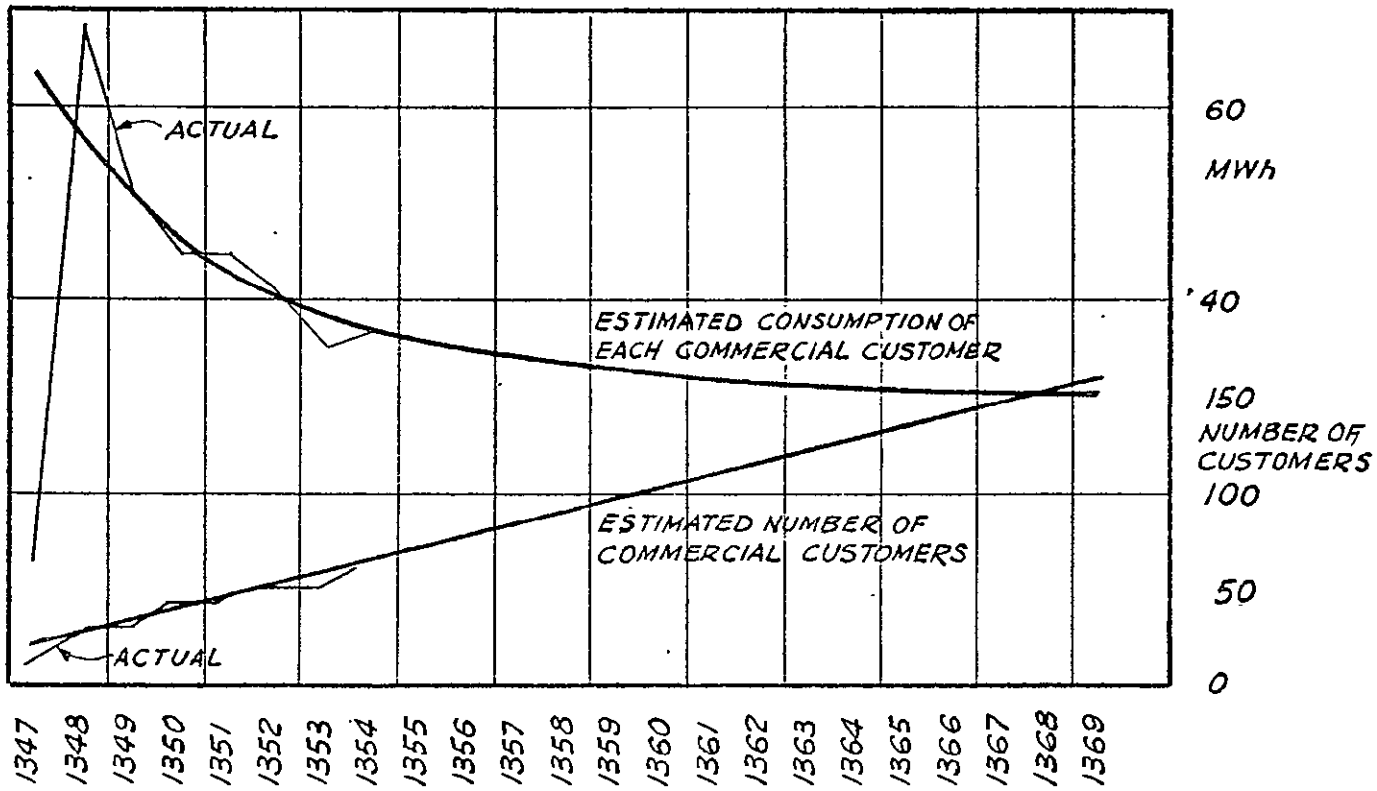


ESTIMATED GROWTH IN THE NUMBER OF BOGHRA BAZAAR CUSTOMERS AND ENERGY CONSUMPTION PER CUSTOMER IN EACH YEAR

Commercial

Although some of the past growth in the number of commercial customers may have been due to the addition of metering to consumers previously receiving unmetered service, it has been assumed that the number of commercial customers will grow at the same linear rate in the future as they have in the past. However, as the number of commercial customers increased in the past, the average use per customer has decreased. For the future it has been assumed that the rate of decrease will less than in the past. Both customer growth and energy use are shown in Figure III-18.

FIGURE III - 18



ESTIMATED GROWTH IN THE NUMBER OF BOGHRA BRESHNA COMMERCIAL CUSTOMERS AND ENERGY CONSUMPTION PER CUSTOMER IN EACH YEAR

Industrial

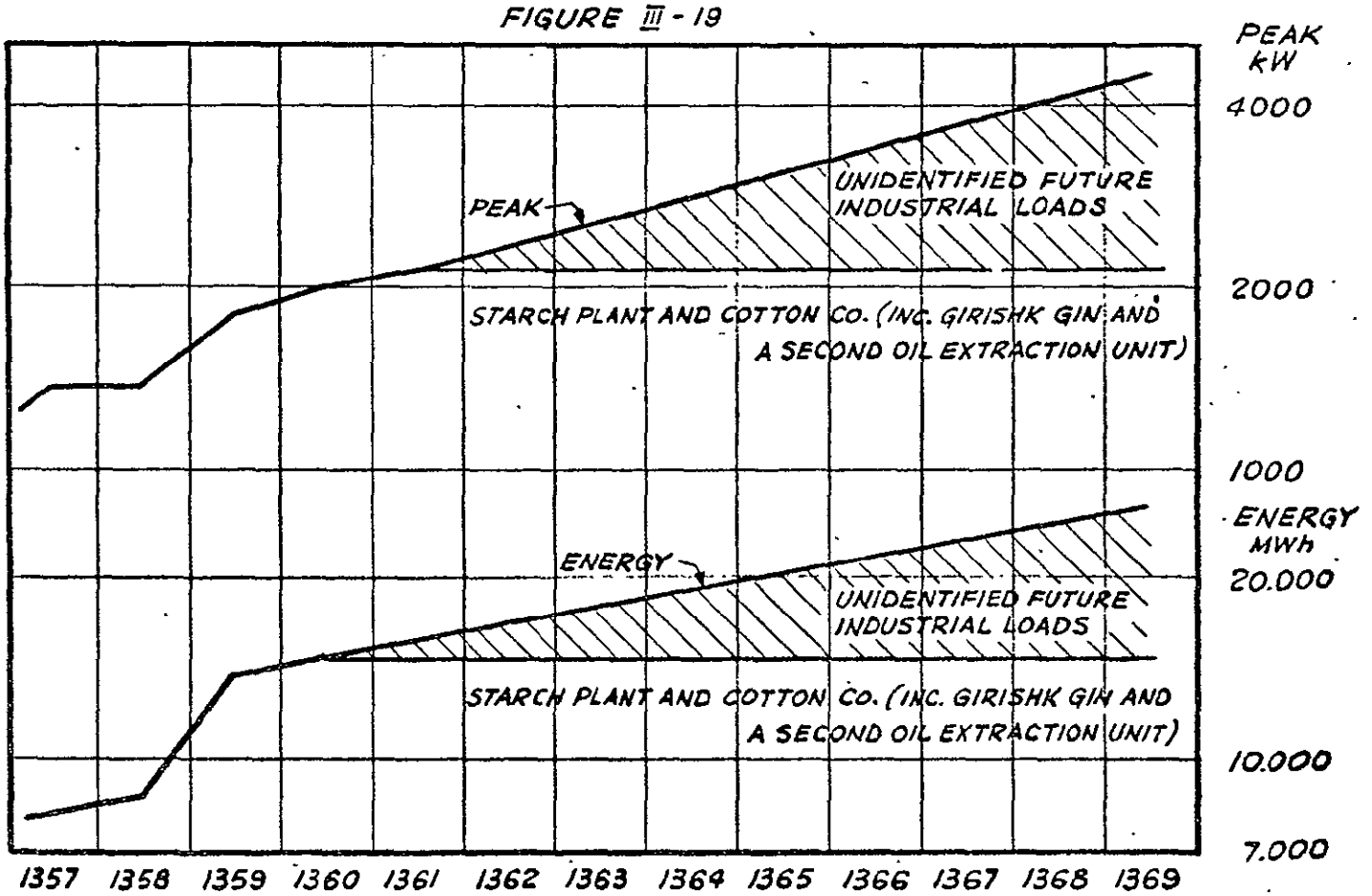
The Cotton Co. in Lashkar Gah, which has been an occasional customer of the Boghra Breshna will become a continuous one when power from Kajakai becomes available and they have purchased and installed a transformer large enough to carry the total demand of the factory. If the entire plant (cotton gin and cotton seed oil extraction plants) had been served in 1354, its peak demand from the system would have been 800 kW with an energy use of nearly 6,000,000 kWh. An expansion program is underway at the Lashkar Gah plant and the construction of a new cotton gin in Girishk will be started later this year. When completed in 1357, the peak requirements for the cotton gin and cotton seed processing will increase to 1,350 kW, with an annual energy requirement of 8,000,000 kWh and will increase to nearly 10,000,000 kWh when the new facilities are fully utilized.

The present expansion program of the Cotton Company includes equipment that will increase the output of the existing cotton seed extraction mill by about 25%. But with the addition of the new gin at Girishk, there will be more cotton seed available than the present facilities can process even with its increased capacity. While a new oil processing plant or additions to the existing one are not in any of the expansion plans, it has been assumed that an additional cotton seed oil plant will be constructed in the Boghra Breshna service area within the next decade.

A small starch plant that will use about a million kilowatt hours a year is planning to locate in Lashkar Gah and is expected to begin operations by 1360.

Further industrial growth will undoubtedly take place in the future and Figure III-19 shows an estimate of unidentified industrial growth in the years after the expansion of the cotton industry and new starch plant have been completed.

FIGURE III - 19

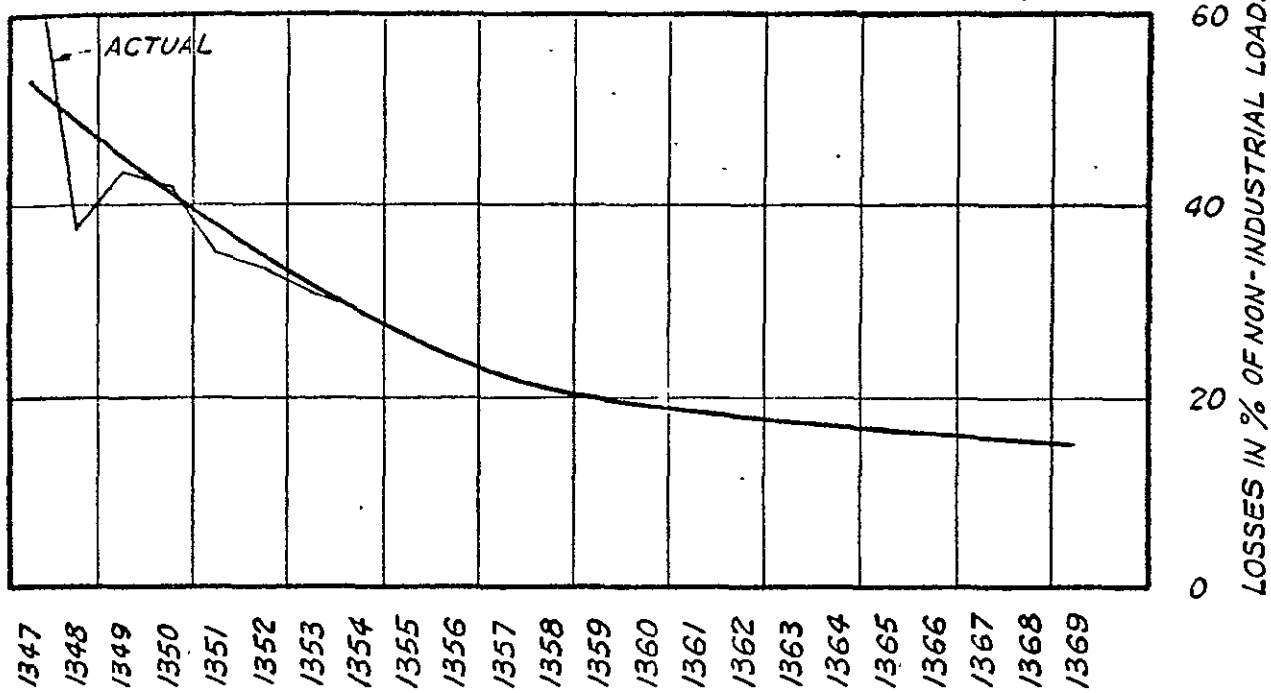


ESTIMATED FUTURE INDUSTRIAL LOADS OF THE BOGHRA BRESHNA

Losses

The energy that is not metered in the form of the electrical losses and unmetered customers, has been decreasing both in kWh and as a percentage of the energy generated. It is the expectation that the number of non-metered customers will continue to decline, but it is unlikely that they will be completely eliminated. If this trend continues, these losses will be down to 15% of the non-industrial load as is shown in Figure III-20.

FIGURE III - 20



ESTIMATED NON METERED LOADS AND ELECTRICAL LOSSES OF THE BOGHRA BRESHNA

Load Factors

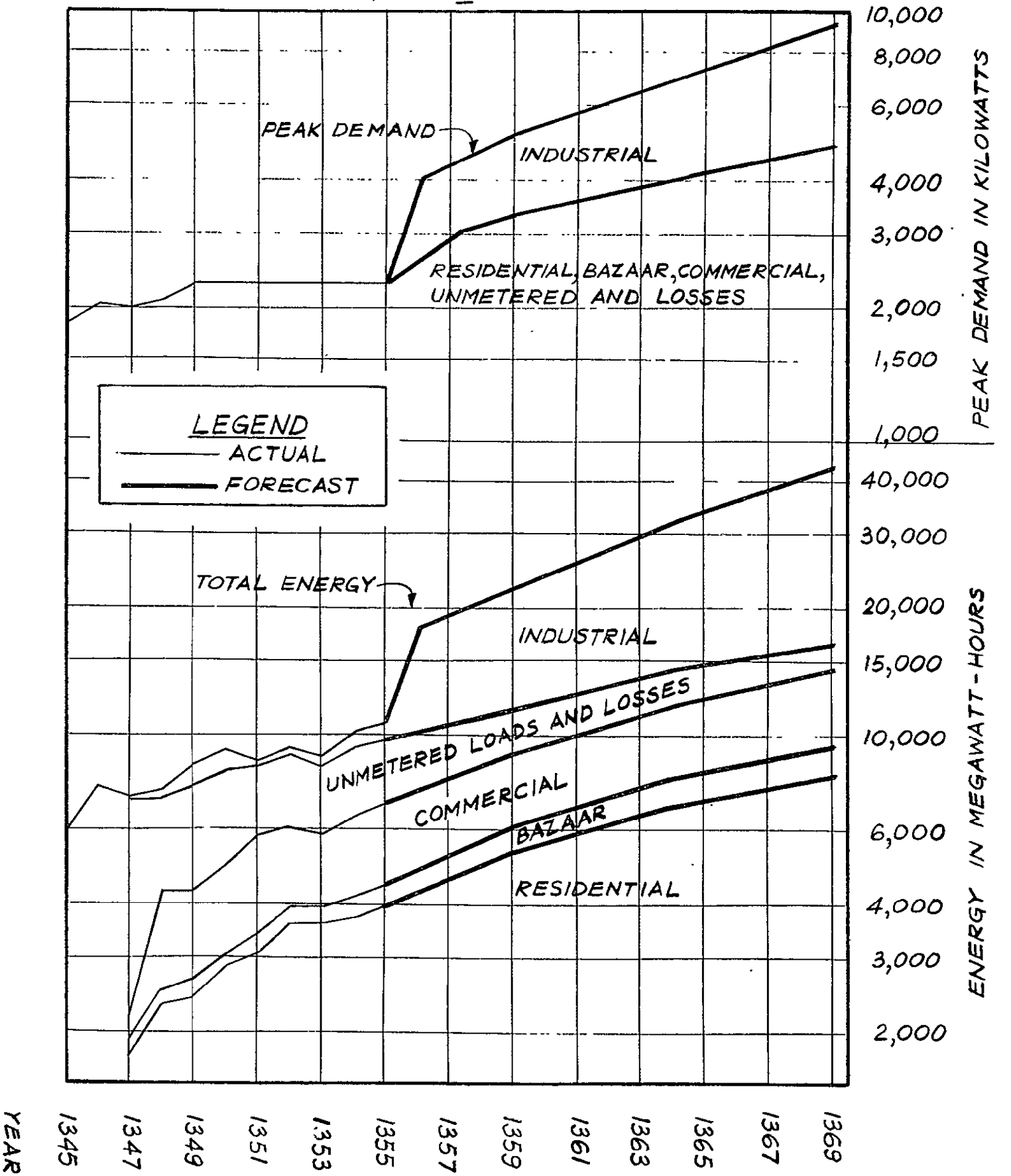
Prior to the year 1350, the Boghra system annual load factor was more or less constant, averaging about 40.5%. Rationing in the past five years has distorted the load factor, but if the non-industrial load of 1354 is adjusted for the rationing, it would have been the same as in the pre-rationing years. The residential, bazaar and commercial customers expected to be added in the future should not significantly affect the load factor fot these classes of loads. Therefore, a constant load factor of 40.5% has been used to determine the future peak demands of the non-industrial loads.

Future Loads - Boghra Breshna

The projection of the combined electric demands and consumption of the industrial, residential, bazaars, and

comercial users together with unmettered customers and system losses for the Boghra Breshna are shown in Figure III-21. This projection assumes that there will be ample generating capacity available in the future and that existing distribution systems will be extended to serve the potential customers. This same information is shown in tabular form together with the numbers of customers in each classification in Section II, Summary. It is anticipated that the electric demand on the Boghra system will be 5,100 kW in 1359 (1980), 6,800 kW in 1364 (1985) and 9,300 kW in 1368 (1990). The corresponding energy requirements in megawatt hours will be 22,400, 32,000, and 43,000 respectively.

FIGURE III-21



FORECAST OF PEAK DEMANDS AND ENERGY REQUIREMENTS
BOGHRA BRESHNA

System Growth-Kendahar Breshna

General

At the end of 1354 there were 5725 residential customers in Kandahar, nearly 1700 bazaar connections, 325 commercial users, and 17 industrial orgnizations that are or will be power customers. This is the only historical data that is available. Since rationing was so heavy for so long, past energy use data is meaningless and the survey of a sample of the energy users, as would be expected, indicated that there average consumption was well below that of the Nangarhar and Boghra Breshnas.

Kandahar is estimated to have a population of about 175,000. The Boghra Breshna which includes Lashkar Gah, Girishk, Nad-i-Ali, Chah-i-Anjir, Marja, and Bolan Lashkar Gah has an estimated population of 15,000 and the entire Boghra area about 33,000, or about one fifth the size of Kandahar.

The lack of sufficient statistically valid data does not permit projection of future energy consumption and demands based upon historic data. However, the non-industiral customers in the Kandahar service area are like the non-industrial customers in the Boghra service area. Since the Boghra Breshna correlated quite closely with the Nangarhar Breshna in nearly all respects, it is valid to assume that a similar correlation exists between the Kandahar and Boghra Breshnas.

The Kandahar Breshna has not encouraged customers to take electric service because of the severe shortage of generating capacity. The use of electric energy has been further discouraged because of the much higher rate charged, 3 Afs. per kWh, compared with 1 Af. in the Boghra Breshna. This higher rate stems from the high fuel cost for the diesel generators. A new rate of 1 Af per kWh will be placed in effect when the power from the Kajakai Hydro becomes available. As soon as this occurs, there will be an initial surge in new customers in those areas where they can readily be connected to the system.

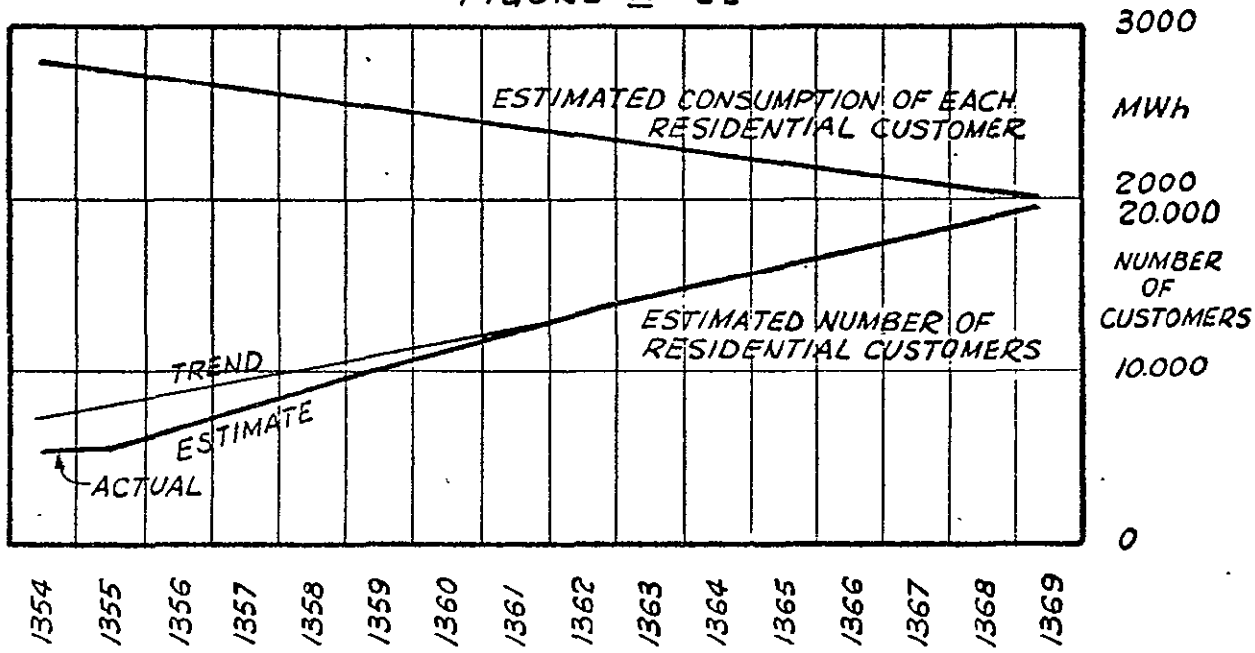
Residential

There are 5725 residential electrified households in Kandahar. If adequate electric generating capacity had been available and the distritubtion system adequate, their

energy consumption would have been about 16,000,000 kWh in 1354, if the usage per customer had been the same as in the Boghra Breshna. This presupposes that there are the same proportion of high use residential consumers in Kandahar as there are in Lashkar Gah.

Figure III-22 indicates the actual number of customers in 1354 and the increase in customers, using the trend line derived from the Boghra system except for the first few years after Kagakai power becomes available.

FIGURE III-22



ESTIMATED GROWTH IN THE NUMBER OF KANDAHAR BRESHNA RESIDENTIAL CUSTOMERS AND ENERGY CONSUMPTION PER CUSTOMER IN EACH YEAR

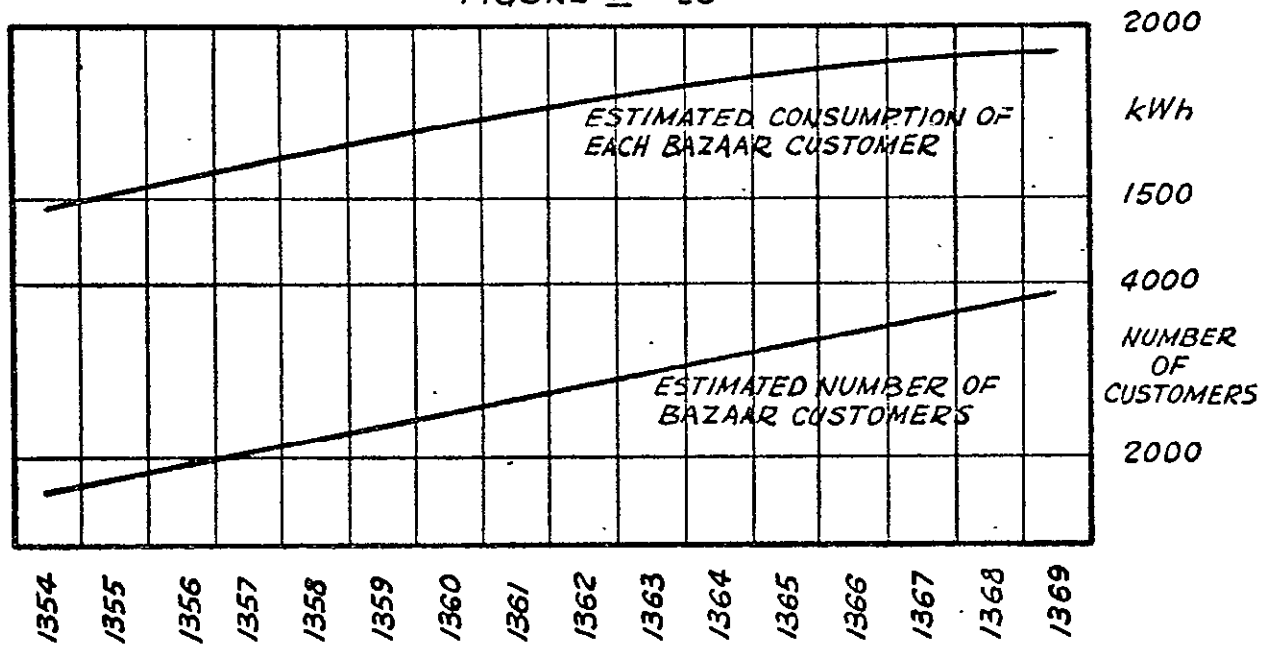
Bazaars

There are about 7,000 merchants in the bazaars of Kandahar with nearly 1,700 having electric meters. As in Lashkar Gah, many metered customers provide electrical service to one or more neighbors and presumably this practice will continue. The Bazaars of Kandahar are of the same type and carry on the same activities as those in the Nangarhar

and Boghra Breshnas, and should have the same pattern of growth in numbers and energy consumption. It is assumed that the number of bazaar customers will increase linearly as in the Boghra Breshna.

The projected increase in bazaar customers and their energy use is shown in Figure III-23.

FIGURE III - 23

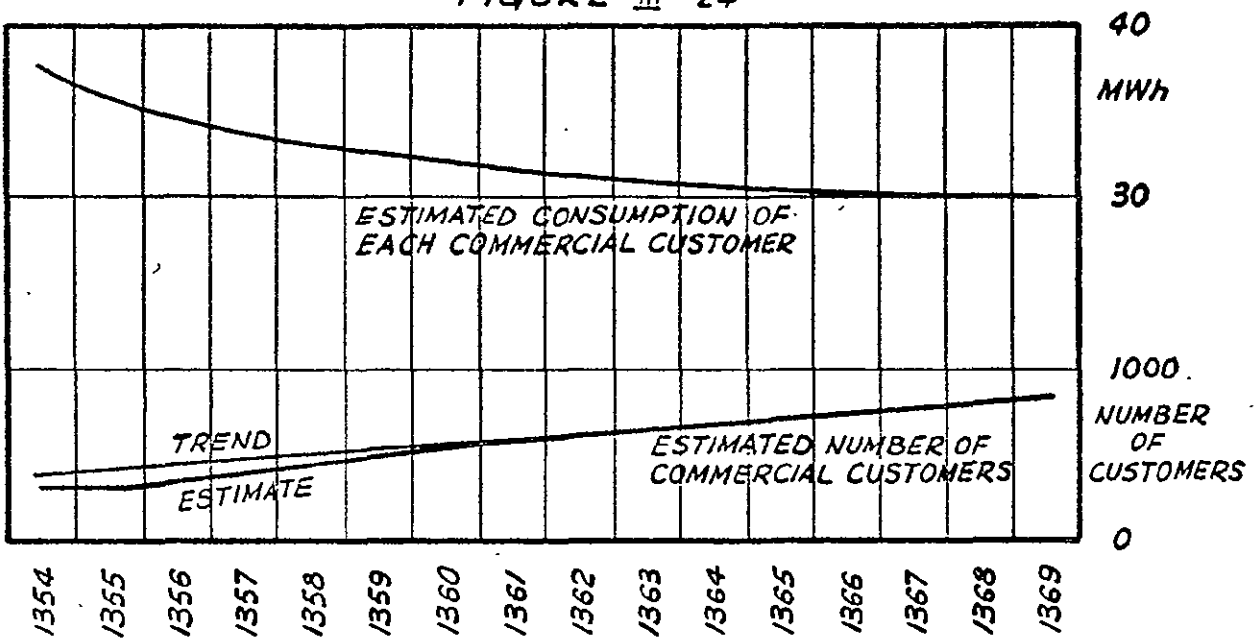


ESTIMATED GROWTH IN THE NUMBER OF KANDAHAR BRESHNA BAZAAR CUSTOMERS AND ENERGY CONSUMPTION PER CUSTOMER IN EACH YEAR

Commercial

There are 325 commercial consumers connected to the Kandahar system and an unknown number that have an auxiliary source of power. As the population of Kandahar increases, the commercial enterprises will also increase in number. The projected increase in commercial customers and the average usage per customer based on the Boghra Breshna are shown on Figure III-24. It is assumed that those consumers now using auxiliary power will take full service from the Kandahar Breshna within four or five years after power from Kajakai Hydro is available.

FIGURE III-24

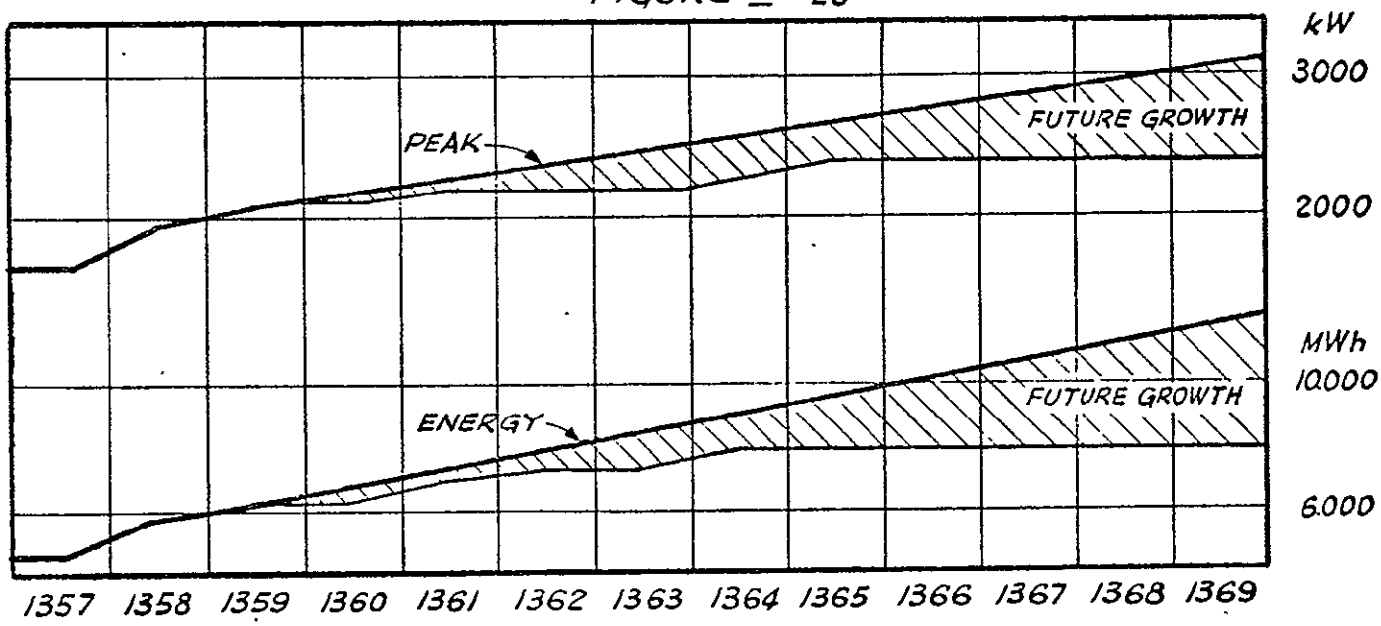


ESTIMATED GROWTH IN THE NUMBER OF KANDAHAR BRESHNA COMMERCIAL CUSTOMERS AND ENERGY CONSUMPTION PER CUSTOMER IN EACH YEAR

Industrial

There are now seventeen organizations classified as industrial customers in Kandahar. While some have a connection to the power system, all use diesel driven generators for half or more of their requirements. The energy purchased from the Breshna is known, but very little information is available on the energy produced from their own generators. In the survey of each of these customers some indicated an increase in their power requirements in the next one or two years. Kandahar is a growing community and with the availability of the lower cost power from Kajakai there should be a continued and uniform growth of the industrial load, both by consumers that are connected now and new ones that will develop in the years to come. This is shown graphically below.

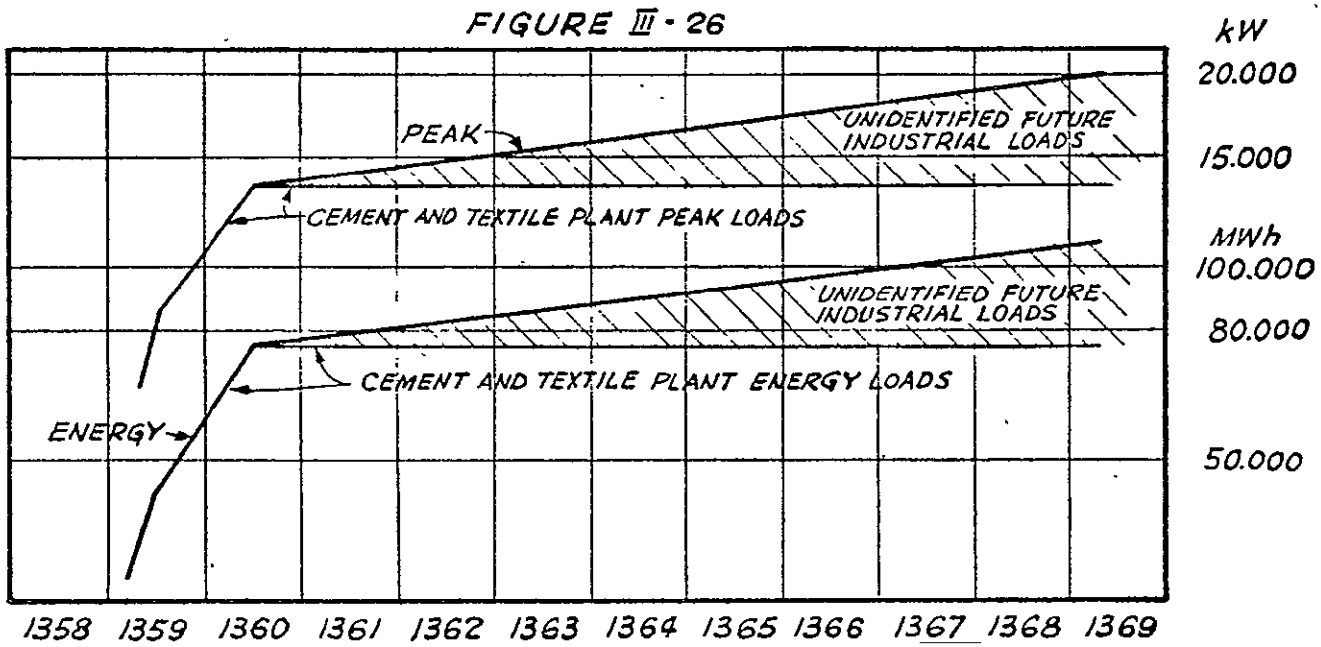
FIGURE III - 25



GROWTH OF EXISTING INDUSTRIAL LOADS IN THE KANDAHAR BRESHNA

The Ministry of Planning of the GOA expects two new large industrial plants to be constructed in Kandahar within the next three or four years, one, a 400,000 ton per year cement plant, and the other, a 40,000,000 meter per year textile mill. The projection of industrial loads shown in Figure III-26 assumes there will be continuous industrial growth in addition to these two identified new plants.

FIGURE III-26



THE NEW CEMENT AND TEXTILE PLANT LOADS AND UNIDENTIFIED FUTURE INDUSTRIAL LOADS IN THE KANDAHAR BRESHNA

Losses

Usage by non-metered customers and the electrical losses in the Kandahar system have traditionally been high. In recent years this has been approximately 40% of generation, higher than the Boghra system. The non-metered consumers in Kandahar such as street lights, potable water pumps, and government buildings possibly have a higher priority than other consumers for the available energy.

When an adequate supply of electric energy is available, more metered customers will be added to the system, which

should result in the non-metered component of the load to decrease in proportion to the total system load, and be similar to the Boghra system. On this basis, the curve for losses and unmetered loads shown on Figure III-9 should apply.

Load Factor

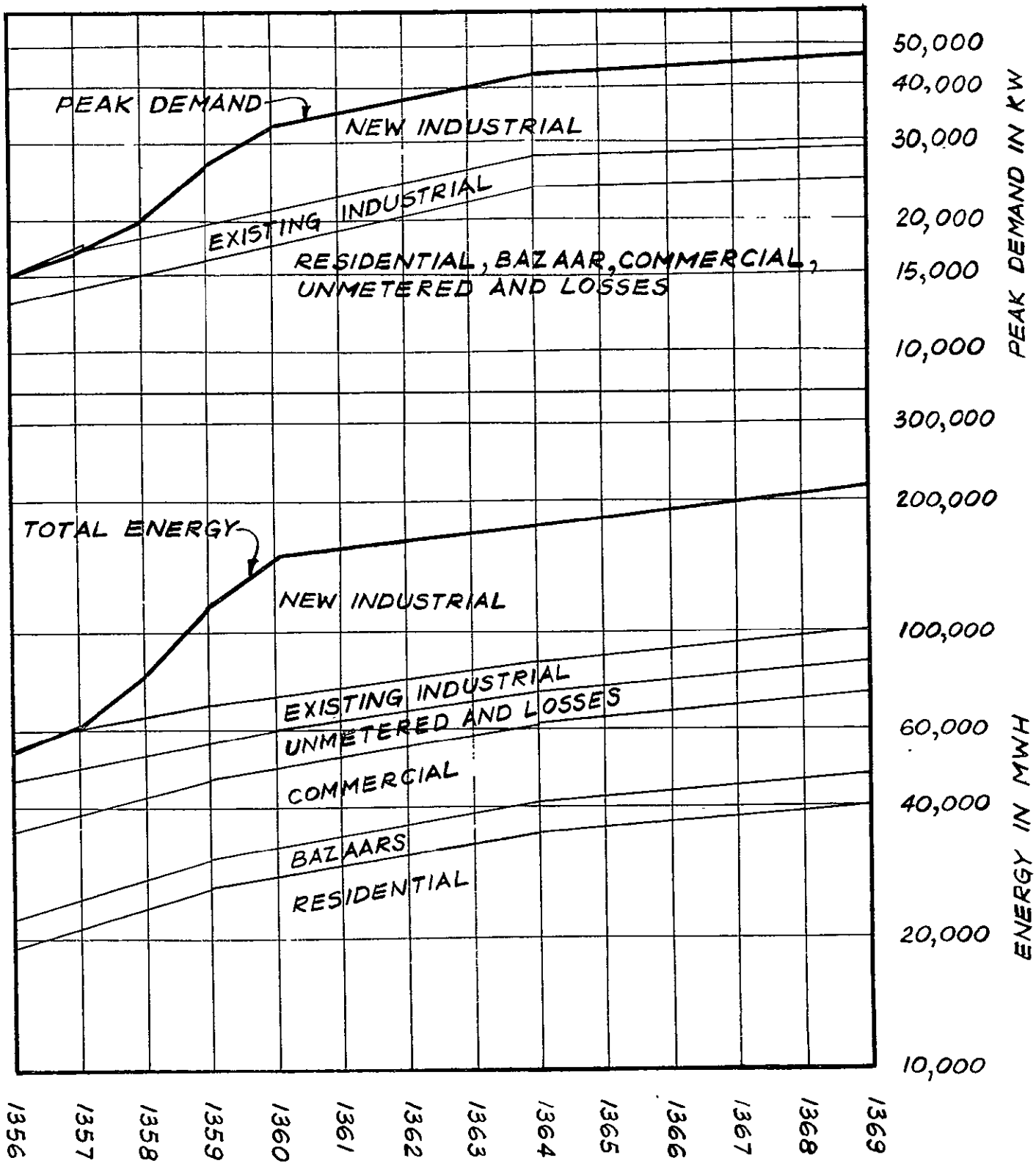
The non-industrial loads severed by the Kandhar Breshna are similar in every aspect to the non-industrial loads served by the Boghra Breshna. As the climate is the same in both service areas, there will be no difference in electric demands and consumption due to climatic causes. The non-industrial load factor should be the same for both systems.

Future Loads - Kandahar-Breshna

The projection of the combined electric demands and consumption of the industrial, residential, bazaars and commercial users together with unmetered customers and system losses for the Kandahar Breshna are shown in Figure III-27. As for the Boghra Breshna, the projection assumes that there will be ample generating capacity available in the future and that existing distribution systems will be extended to serve the potential customers. This same information is shown in tabular form together with the number of customers in each classification in Section II, Summary.

It is anticipated that the electric demand of the Kandahar system will be 26,900 kW in 1359 (1980), 43,000 kW in 1364 (1985) and 47,700 kW in 1369 (1990). The corresponding energy requirements in megawatthours will be 113,500, 175,500 and 211,500 respectively.

FIGURE III-27



FORECAST OF PEAK DEMANDS AND ENERGY REQUIREMENTS
KANDAHAR BRESHNA

Kajakai Service Area Load Estimate

There is potential for rural electrification in the Helmand and Arghandab Valleys. This is discussed in detail in Section IV of this report. The extent to which this potential will develop will be dependent upon the cost of the energy to the consumer. For the purpose of projecting the electric demand and energy consumption in the Kajakai Service area, the rural usage associated with a tariff of three Afs. per Kilowatt-hour has been used.

The projected peak demand and energy requirements of the combined Kandahar and Boghra Breshnas, including that contributed by rural electrification are graphically shown on Exhibit VII and in tabular form in Section II, Summary. It is estimated that the electric demand will total 34,000 kW in 1359 (1980), 50,000 kW in 1364 (1985), and 65,000 in 1369 (1990). The corresponding energy requirements are estimated to be 142,000, 217,500 and 278,500 megawatt-hours respectively.

The rate of growth in electric energy consumption during the first few years after power from Kajakai becomes available is quite high, from 21,700 megawatt-hours in 1354 (1975) to an estimated 142,000 megawatt-hours in 1359 (1980). However, in the decade following 1359, the rate of growth in electric energy consumption is expected to be at a lower rate as an anticipated downward trend in the average use by residential and commercial consumers will not be offset by the increase in their numbers.

Previous Load Estimates

R. W. Beck and Associates report entitled "Electric Power Survey Report" of November 1964 recorded the results of a comprehensive study of the power situation in the Helmand - Arghandab Valley. Included was a load forecast of the power and energy requirements based on a unit at Kajakai operating by mid 1968, with successive units to ensure adequate power in the future years. This, of course, did not happen, and now nearly twelve years later, the loads of the valley have only doubled instead of the fourfold increase forecasted in 1964.

Thomas M. Hill of the Rural Electrification Administration, in a July 1966 report on an "Economic Appraisal Study and Power Requirements Study" of the area, estimated that the

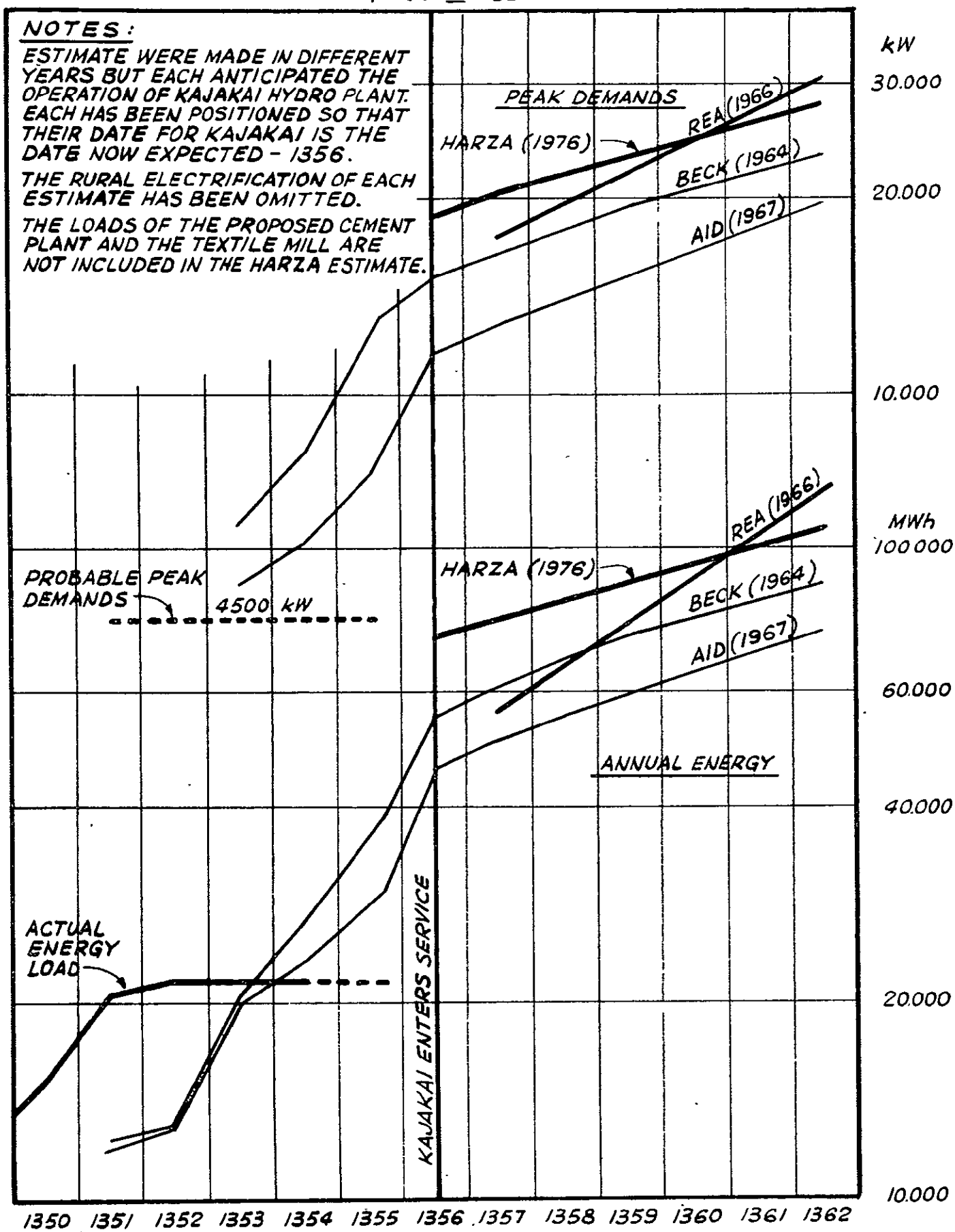
1975 energy load would be about six times greater than the 21,700 mWh that were actually supplied by the generating stations. Once again, the resources necessary to supply the loads did not materialize.

These load estimates were reviewed by an AID committee and the results published in a Capital Assistance paper dated April 25, 1967. Assuming that Kajakai would be producing power in 1971, the committee estimated that the 1975 energy requirements of the areas served by the Boghra and Kandahar Breshnas would be about 60,000 mWh.

There are always hazards in predicting future loads but nothing can be as calamitous as has happened with these earlier estimates. Installed generating capacity was expected to increase from 5 to 38 Mw, three or four years after each estimate was made, but instead, now some 9 to 12 years later, the capacity available to serve the consumers has decreased from five to not much more than four MW.

The three previous estimates were made in different years but each anticipated the operation of the Kajakai generating station. These earlier estimates are shown in Figure III-28, positioned so that their date for service from Kajakai is the one now expected - 1356. Even though conditions have changed in the past decade, and therefore, a load estimate of today may not be comparable to the ones of the past, the result of the current study, excluding the cement plant and textile mill which were not foreseen until recently, are also presented on the graph.

FIGURE III - 28



PREVIOUS LOAD ESTIMATES AND THE HARZA PROJECTION OF 1976

Conclusions

At the present time consumers in the Boghra Breshna and Kandahar Breshna service areas use only about 100 kWh per capita per year. The energy load projection anticipates that this will increase to 700 kWh five years after Kajakai power becomes available in the region. The availability of the Kajakai power alone will not be sufficient to enable this growth in energy consumption. The distribution systems must be extended into new sections of the cities; distribution voltages standardized; the large new industries must become realities and the existing customers must replace their private generation with service from the Breshna systems.

In the presently electrified areas all those householders now without service have the desire for electric energy. Some lack the money to pay for the connection and/or to pay for the energy; others cannot obtain service because the distribution lines do not pass their dwelling.

Rural householders have the same desire. While not fully aware of what electrical energy might do for him, a farmer, 140 km south of Lashkar Gah, voicing the sentiment of all farmers in the area stated that electricity would make life on the farm more like living in the cities.

If the new industrialized loads become a reality, existing consumers having their own generation obtain all their requirements from the Breshna systems, service is provided to all the potential consumers in the existing electrified areas and distribution systems constructed and service provided to all potential customers in the presently non-electrified areas, the electric demand in the Kajakai Service Area is projected to be 34,000 kW in 1359 (1980) and 65,000 kW in 1369 (1990). The firm capacity at Kajakai of 22 MW will be exceeded by 1358, and will require the operation of the existing hydro and diesel plants to neet the load requirements. If the new industrial loads do not materialize and existing consumers with their own generation do not take all of their requirements from the Breshna systems, but the non-industrial loads develop as projected, the firm capacity of Kajakai will be sufficient to serve the electrical requirements of the area through the year 1361. (1982).

There is a serious lack of meaningful, valid data throughout the Kandahar and Boghra Breshnas. Methods and procedures

should be implemented to gather, compile, and analyze statistical data on all classes of consumers, including those presently non-metered. Such data should also include kWh send out from generation, substation equipment and circuit loadings and other pertinent data necessary for technical analysis of system conditions and for forecasting future load and energy requirements.

SECTION IV

ECONOMIC EVALUATION

Section IV

ECONOMIC EVALUATION

Rural Electrical Energy Demand

General

The Helmand - Arghandab region is the center of one of the major development efforts of the Government of Afghanistan. Since 1946 the Government has carried out important agricultural and irrigation development projects in the region. A recent World Bank agricultural and rural development sector report[1/] indicates progress to the end of 1974 (1354) was as follows:

POTENTIAL IRRIGABLE
AND PRESENTLY IRRIGATED AREAS,
UPPER HELMAND AND ARGHANDAB VALLEYS

	Helmand Valley	Arghandab Valley	Total
	(Hectares)		
Total irrigation potential	242,800	89,000	331,800
Irrigation potential with present water flow control	161,900	68,000	229,000
Area being irrigated	121,400	52,600	174,000
Area provided with adequate drainage by HAVA[2/]	17,800	8,700	26,500

1/ Afghanistan Opportunities for Agricultural and Rural Development Sector Report, IBRD, November 1975 (1354).

2/ Helmand-Arghandab Valley Authority.

In 1975 (1354) the Kajakai Market Service area's population was estimated as follows:[1]

	Helmand	Arghandab	Total
Rural	325,000	192,800	518,400
Urban	32,400	174,900	207,300
Total	358,000	367,700	725,700

With expansion of irrigation, growth in population and income, the demand for modern infrastructure facilities in the area has increased. One of the major requirements is a modernized and expanded electrical distribution system. This part of Section IV provides an estimate of the rural demand for electricity and the ability and willingness of the farm families to pay for electricity.

Methodology

An estimate of the potential rural demand for electricity in the Kajakai Power Market service area is based on the following considerations:

(1) The present value of farm production, farm income and the number of farm families in the area.

(2) The increase in farm production and income that has occurred in the area within the last five years.

(3) An estimate of the distribution of the total farm income to various income groups (farm-families).

(4) Projection of the area's future agricultural production and income levels based on Government planning objectives and appraisal reports prepared by different planning organizations.

(5) A survey of the present energy consumption of the farm population in terms of kinds of energy used and the quantities and costs thereof.

1/ Assuming a 2.5 percent annual growth ratio between 1970 (1349) and 1975 (1354).

(6) A survey of the potential consumer's attitude regarding use of electricity and their willingness and ability to pay for electricity and the ancillary costs (wiring, appliances, etc.)

(7) A survey of a presently electrified area in Afghanistan (Jalalabad) to determine energy consumptions levels, costs and family income relationships that may be used in estimating future rural demand levels in the Kajakai service area.

(8) A review of family income and energy cost relationships in several developing countries in Asia.

The Kajakai Power Market service area is subdivided into ten subareas in the Helmand Valley corresponding to the service areas of the Helmand - Arghandab Valley Authority (HAVA). HAVA is an agency responsible for agricultural development in the Upper Helmand Valley, in certain areas of the Lower Helmand Valley located in Nimroz Province and in the portion of Kandahar Province irrigated below the storage dam on the Arghandab River. For purposes of this study the HAVA service areas in the Upper Helmand and Arghandab Valleys were combined into potential rural energy demand areas, the boundaries of which reflect logical power system distribution regions that may be served separately or as part of an overall staged expansion program. None of these areas are electrified at the present time. For the Upper Helmand and Arghandab Valleys the HAVA service areas are combined into Rural Energy Demand Areas as follows:

Helmand Valley

Rural Energy Demand Areas	HAVA Service Areas
A	SANQUIN-KAJAKAI, MUSA QUALA
B	SERAJ, CENTRAL GIRISHK, NOWZAD
C	NADI ALI, MARJA, SHAMALON
D	DARWESHAN, KHANISHIN
Arghandab Valley	MAIWAND, DAND-DAMAN, ARGHANDAB AND PANJUAI

A map of the areas is shown in Exhibit I.

Two Rural Energy Demand Areas in the Upper Helmand Valley, B and C, were analyzed in a detailed market survey.

These areas are logically expected to be included in any electrification program approved for the Upper Helmand Valley. Family income, energy cost and consumption relationships developed for Rural Energy Demand Areas B and C were applied to farm income and population estimates projected in and Rural Energy Demand Areas A and D and also Kandahar province to determine total rural electrical energy (Kwh) demands. These regions comprise the existing boundaries for the rural energy demand of Kajakai power. Other areas, in the Lower Helmand Valley or elsewhere, may subsequently be included if and when the potential market areas for Kajakai power are expanded in the future.

A survey of farm families was undertaken with the assistance of HAVA extension personnnel during March and April 1976 (1355). The survey of present energy use characteristics of the farm families in the Upper Helmand Valley was included as a supplement to the on-going 1975 (1354) Farm Economic Survey (FES) conducted jointly by AID and HAVA. The present FES, based on a five percent sample of the farms in the Upper Helmand Valley, is intended to update the data on farm family socio-economic characteristics developed in the 1970 (1349) FES of the Helmand and Arghandab Valley. The supplemental energy use survey was based on a subsample of 175 farm families. The families surveyed were selected at random from all HAVA service areas in the Upper Helmand Valley. Sample data were combined to develop information on a 'rural demand area' basis. Net farm family income estimates were calculated by relating information contained in the 1970 (1349) FES, data from the supplemental energy survey and the most recent crop production estimates for each HAVA service area provided by HAVA's Department of Statistics. The adjusted net farm family income (NFFI) figures can be revised as required when the main 1975 (1354) FES data are made available.

Project Areas Crop Production and Value

The latest agriculture production figures for the Upper Helmand Area are for 1974 (1353). A comparison of 1970 (1349) and 1974* (1353) cultivated area and gross value of production for two main crops --wheat, and cotton -- shows that a significant increase in gross value of agricultural

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* Subsequent references will be in terms of the Moslem year; 1970 (1349), 1974 (1353), 1975 (1354), 1980 (1359), 1985 (1364), 1990 (1369).

production occurred in the Valley during the last several years. Expansion of the improved wheat and cotton area, plus higher yields and farm gate prices resulted in farm income gains in all HAVA service areas. The cultivated area of improved wheat increased from 5,700 to 42,600 ha and cotton from 6,000 to 27,000 ha. In 1353 the total increase in gross value of production of the two crops combined was approximately three times the 1349 level.

Appendix Tables 1 and 2 show the cultivated area and value of production for wheat, corn, and cotton for each for the two years, 1349 and 1353.

Net Farm Family Income (NFFI): Present

An estimate of the present (1354) NFFI was made for the two power demand areas, B and C, combining data developed in the supplemental energy survey, the latest crop production estimates provided by HAVA and data on gross and net farm income contained on the 1349 FES.

The adjusted average 1354 NFFI and the percentage increase over 1349 is shown in detail in Appendix Table 3 and is summarized below:

	Area C	Area B
	Nadi Ali Marja Shamalon	Seraj Central Girishk Nowzad
1354 Ave. NFFI (Afs)	50,000	36,300
1349 " " "	35,400	23,500
Average Annual Rate of Increase 1349 to 1354 (%)		
Current Prices	9.1	7.1
1354 Prices	5.0	3.4

NFFI Projections: 1354 to 1359 and 1359 to 1369

Projections of NFFI for each area were based on estim-

ates of net irrigable area, the present level of cultivation, the development potential and project plans for development as outlined in several reports on the Upper Helmand Valley.[1/]

Appendix Table 4 shows the projections of NFFI for both Rural Energy Demand Areas B and C for the 1354 - 1359 period.

The regional development study prepared by International Engineering Company concludes that Seraj in Area B and Lower Shamalon in Area C can realize significant increases in agricultural production with the installation of project facilities in a phased development program. Also, on-going drainage studies in Nadi Ali and Marja in Area C detail the facilities necessary for increased crop production in each area.

A significant factor in the farm income growth in Helmand Valley during the 1349-54 period was the expansion of cotton production as previously noted. A recent World Bank Sector Report recommended that the Government (1) continue the encouragement of cotton production for export and (2) establish a wheat price that ensures an adequate return to the grower and provides an incentive to use more intensive technology but will not lead to the displacement of cotton by wheat. World Bank studies indicate that future (1364) cotton and wheat prices could average around 77 and 36 Afs per md., respectively.[2/] The 1354 FES prices for cotton and wheat average 60 and 30 Afs. per md., respectively.

1/ (a) Helmand-Arghandab Valley Project Area Analysis. A.R. Baron. June 1962.

(b) 1970 (1349 FES Helmand-Arghandab Valley. G.P. Owen, December 1971 (1350).

(c) Agricultural Development Plan. Upper Helmand Valley. International Engineering Co. December 1975 (1354).

2/ "Afghanistan Opportunities for Agricultural and Rural Development Sector Report" two Volumes IBRD, November 1975 (1354).

For the 1354-1369 period, NFFI projections assume a higher average annual growth rate than that experienced in the 1349-1354 period due primarily to the continued expansion of cotton and improved wheat production and the additional settlement opportunities made possible by the installment of new project facilities in the Upper Helmand Valley Areas.

Appendix Table 5 shows the projections of NFFI for both areas for the 1354-69 period. The average annual growth rates are summarized below:

	1349-54	54-59	59-64	64-69
	Percent			
Area B	3.4	10.0	8.0	5.0
Area C	5.0	12.0	6.0	5.0

The projected NFFI are used to establish the economic framework for estimating the potential demand for electricity of the farm population in each area. The distribution of NFFI by various income groups (farm families) is assumed to remain constant during the 1359 - 1369 period. This assumption may be revised as additional information becomes available. Also, as development plans materialize the projected growth in average NFFI can be adjusted as required.

Present Energy Use: Type, Quantity and Costs

The supplemental energy survey provided data on the present level of energy use by the farm families in the Upper Helmand Valley. Of the traditional sources of non-electrical energy, wood and kerosene are the most important. Wood is predominantly for heating and cooking and kerosene for lighting. Other sources of energy are crop residue and dung. Of the four sources, kerosene is purchased, crop residue and dung provided by the family's own sources and wood both purchased and supplied by the farm family. Sample data for Rural Energy Demand Areas B and C (119 families) indicates the following pattern of utilization of the two main non-electrical energy sources-wood and kerosene:

Demand Area B	Percent of Families Using	Percent of Families Purchasing	Ave. Annual Cost/Family (Afs.)	Percent of Average NFFI
Wood	100	23	852	2.3
Kerosene	100	100	686	1.9
		Total	1,538	4.2
Demand Area C				
Wood	94	16	998	2.0
Kerosene	94	94	682	1.4
		Total	1,680	3.4

For both areas the weighted average cost is 3.7 percent of average NFFI.

The quantity of wood used per farm family varies depending on whether the family is self-supplied or purchased all or a significant quantity from other suppliers. The average quantity used per family in Rural Energy Demand Areas C and B is summarized below:

	Purchasers	Self-Suppliers	Total
Usage Per Month (mds)	41	67	
Usage Per Year (mds)	492	804	
Total Quantity Used Per Year			
mds (000)	1,097.2	7,372.7	8,469.9
Metric Tons (000)			38.5
Number of Families in Areas B and C 1/			11,742
Non-Users	342		
Purchasers 1/	2,230		
Self-Suppliers 1/	9,170		
	11,742		

For kerosene, consumption averaged 1.1 gallons per family per month or 14.4 gallons per year. With 97 percent of the families purchasing, the total quantity consumed in areas B and C per year is 164,000 gallons. The implied annual per capita 2/ utilization of wood and kerosene in both areas is 750 lbs and 1.5 gallons, respectively.

1/ Total number of farm families from HAVA Department of Statistics, see Appendix Table 20. The total number of purchasing and self-supplying families estimated from sample data.

2/ Assuming an average family size 9.6 persons.

Note: 1 Maund (mds) = 4.416 Kg = 9.736 pounds.

Slaughe 7/8/80

0 cattle
0 Land

needs cat
and Land

Appendix Table 6 shows the relationship of NFFI and energy cost in both areas.

The weighted average energy cost of 3.7 percent of NFFI is considerably below present energy cost for town households in the Kajakai Service Area and for those families surveyed in the Jalalabad Area. The primary reason for the lower out of pocket cash cost is the amount of fuel self-supplied by the farm population. The opportunity cost of the wood gathering and transporting activites of the farm family has not been assessed. This cost exists to the extent that such activities are undertaken by family members who must forego or restrict other productive pursuits. Several families surveyed indicated that the availability of electrical energy would allow more time for farming and hence recognized the implied cost of using the present source. This was not a frequent comment, however, and from present data it is not possible to assess the non-cash costs of the self-supplying families.

Willingness to Pay for Electricity

The energy survey asked each family what was (1) the maximum amount they could afford to pay for electricity each month and (2) what was the maximum amount they could afford to pay for connection charges.

For the two areas the results, shown in Appendix Table 7, are summarized below:

	Ave. per Family (Afs)
Maximum connection charge	3,410
Maximum monthly electricity charge	131
Maximum annual electricity charge	1,572
Annual electricity charge as percent of Average NFFI	3.5

The indicated maximum electricity charge is close to the estimated present total energy cost incurred by the average farm family (3.7%).

The families surveyed indicated that the primary use for electricity initially would be for lighting. The survey results indicate that wood would not be replaced as the primary source of energy for heating and cooking at least

not in the introductory stages of using electrical energy. The maximum connection cost is converted to an average annual equivalent cost by assuming repayment over five years at eight percent interest. The annual willingness to pay per family (excluding appliances) is estimated as follows:

		(Afs.)
1)	Connection cost	
	Capital cost	3,410
	Annual Cost	853
2)	Annual energy cost	1,572
	Total (1) and (2)	2,425
	Percent of Ave. NFFI	5.5

With the inclusion of appliance cost the total annual costs expressed in terms of percent of average NFFI probably would exceed six percent.

A comparison of consumer expenditures by major category for selected countries is shown in Appendix Table 8.

In India and Pakistan the rural population's expenditure for "Fuel and Light" averaged 6.5% of total consumer expenditures, which is reasonably close to NFFI (which includes family savings, if any). On the basis of the sample survey results and considering the experience of other developing countries in Asia it was decided to use six percent as a benchmark figure in estimating the potential rural demand for electricity in the Kajakai service area.

The methodology adopted in projecting potential electrical energy demand is summarized as follows:

1) Farm family expenditures for 'fuel and light' would not exceed 6.0 percent of NFFI.

2) Wood would continue to be used as the primary source for heating and cooking at least in the introductory stages of the rural electrification program.

3) The average annual cash expenditure for wood per farm family is taken at two percent of NFFI (Appendix table 6).

4) The amount of NFFI available to pay for electrical energy (including connection, wiring, appliances), therfore, should not exceed 4.0% of annual NFFI.

Correlating Electrical Energy Consumption Levels and Costs: The Jalalabad Experience

The experience of an existing electrified area, Jalalabad, located on the floodplain of the Kabul River approximately 135 km from Kabul, was used as a guide in establishing the relationship between different consumption levels and the costs associated with each level. Three levels of consumption were identified: level A, lights only; level B, lights and one appliance; level C, lights and two or more appliances. The sample survey results on the Jalalabad consumption and cost relationships are given below:

ANNUAL FAMILY INCOME AND TOTAL COST OF ELECTRICAL SERVICE FOR TOWN HOUSEHOLDS BY LEVEL OF CONSUMPTION (IN AFS) JALALABAD, 1355

Annual Consumption Level	Annual Family Income (000 Afs)	Kwh Per Year	Connection & Wiring C.C.*	Connection & Wiring A.C.*	Lights C.C.*	Lights A.C.	Appliances C.C.	Appliances A.C.*	kWh Energy Cost At 1 Afs	kWh Energy Cost At 3 Afs @	Total Annual Cost/Family 1 Afs	Total Annual Cost/Family @ 3 Afs
A	43.1	717	4900	1227	83	42	0	0	717	2151	1986	3420
B	50.9	1097	5300	1388	110	55	733	367	1097	3291	2847	5041
C	65.5	2168	5470	1370	151	75	4477	895	2168	6504	4508	8844
Average	51.1	1181	5200	1300	108	54	3160	632	1181	3543	3167	5529

* C.C. = Capital Cost; A.C. = Annual Cost. Connection and wiring amortized over 5 years at 8 percent; Lights and small appliances depreciated on a straight line basis over two years; large appliance over 5 years.

For the rural energy demand projections in the Kajakai Service Area the cost-consumption relationships are as follows:

		Total Annual Cost 1 Afs/Kwh (Afs)	Total Annual Cost 3 Afs/Kwh (Afs)
Level A	700 Kwh/year	1,968	3,420
Level B	1,100 Kwh/year	2,847	5,041
Level C	2,200 Kwh/year	4,598	8,844

Projections of Potential Electrical Energy Demands: Rural Energy Demand Areas B and C

Given the projected NFFI of Areas B and C and the electrical energy consumption/cost relationship summarized above, future energy demands were estimated. It is assumed that the highest level of demand would occur provided the total cost is equal to or less than 4.0 percent of NFFI. See Appendix Tables 9 and 10 for the NFFI, electrical energy cost and demand projections.

Potential demand is significantly influenced by electrical energy costs. For example, in the year 1364, 80 percent of families in Area B would have a potential demand for electricity at a kwh cost of 1 Afs. With a kwh cost of three Afs, however, the percent of families with a potential demand would decrease to 16 percent. The level of consumption also varies with the kwh cost. At the one Afs per kwh rate, 30 percent of the families would be at level A, 34 percent at level B and 16 percent at level C. At the three Afs rate, six percent of the families would be at level B and ten percent at level C. A similar analysis was completed for Area C.

With the relationships developed from the detailed analysis of Areas B and C, the projections for the other areas are in terms of (1) the percent of farm families electrified and (2) annual average level of consumption, (kwh) per farm family. Appendix Table 11 shows the number of farm families in each area and the values used to estimate the total electrical energy demand of the farm families in the Kajakai service area. The projection period is to the year 1369. The potential 1354 demand is subtracted from all future demand levels to account for the fact that actual 1354 utilization is negligible. Projections of the total number of farm families are based on information regarding the development potential and settlement opportunities of each area.

Potential Electrical Energy Demands: All Areas

Appendix Table 12 shows the electrical energy demands for each area with a Kwh cost at one and three Afs. Total potential demand increases from six million Kwh in 1359 to twenty-four million in 1359 to thirty-eight million Kwh in 1369 with an energy cost of one Afs per Kwh. Combining Areas B and C and A and D in the Helmand Valley, the regional distribution of electrical energy demand is summarized as follows:

Energy Consumption (Mwh)

Year		Helmand Valley B&C	Helmand Valley A&D	Helmand Valley Total	Arghandab Valley	Total All Areas
1359	1 Afs.	7,008	4,639	11,647	2,766	14,413
	3 Afs.	2,965	1,920	4,885	1,145	6,030
1364	1 Afs.	12,929	9,450	22,379	5,095	27,474
	3 Afs.	4,753	3,429	8,182	1,842	10,031
1369	1 Afs.	18,165	13,204	31,369	7,119	38,488
	3 Afs.	11,287	8,188	19,475	4,414	23,889

Other Considerations

Future energy consumption levels of Areas A and D in the Upper Helmand and for the Arghandab Valley are estimated from the electrification rates and average Kwh per year per farm family derived from detailed studies in Areas B and C. Farm family income characteristics may actually differ in the other areas, especially in the Arghandab Valley. The data from 1349 FES indicates that the average NFFI in the Arghandab Valley was more than double that of the Helmand Valley. Updated information on agricultural production and income in the Arghandab Valley presently is unavailable, nor is information available on the potential for future expansion. For this study the total number of farm families in the Arghandab Valley in 1364 and 1369 was assumed to increase only slightly over the 1349 level. With more settlement opportunities the projected electrical energy demands for the Arghandab Valley would be greater than that estimated herein. Assuming a doubling of the Arghandab's potential demand over that shown above and in Appendix Table 12, the total rural electrical energy demand would increase approximately 20 percent in each time period. Updated information on future production and settlement opportunities is needed before revised estimates can be made.

Using the arbitrary level of 6.0 percent of NFFI to estimate potential electrical energy demands is based on (1) survey information on consumer willingness to pay (2) cost of alternative energy sources and, (3) benchmark estimates of the rural fuel and light cost and income relationships prevailing in other Asian countries. The 6.0 percent level is below the present expenditure level for fuel and light of town households due to the town households greater dependence

on purchased supplies (which is discussed in the next section). Farm families willing to pay more than 6.0 percent would have a greater demand for electricity than that assumed herein. On the other hand survey data shows that the total electrical cost for the basic 'lights only' system is approximately 1,900 Afs. per year for the first five years the farm family is connected. The average cost of 'lights only' by the use of the present source kerosene ranges between 700 to 900 Afs. per year per farm family at present consumption levels. For the farm families that will use electricity only if it is the cheaper source, the basic 'lights only' by kerosene will continue to be preferred. The implication of the present findings is that a significant number of farm families would be willing to incur a higher initial cost (within the limits indicated) than that of the present alternative -- kerosene-in order to have electricity.

The projections of farm family electrical energy demands is taken as equal to the total 'rural' demand. Other potential rural demands, most notably, for farm productive uses have not been included in the total. Present farm productive use of electricity is practically non-existent. On the basis of information obtained in the survey and from HAVA Extension Service Personnel farm productive uses of electricity in the foreseeable future will continue to be neglible. Electrical energy also may be needed by the more technically advanced agro-industries - processing, drying, storage facilities - if and when they are established in the rural areas. Present information does not provide a basis for projecting potential demand in these categories. This aspect should be reviewed as the development plans materialize in each rural area. The agro-industrial loads are included in the town projections which are presented and discussed in detail in Section III.

Other potential electrical energy uses in the rural areas include modernized village water supply systems, district drainage and major irrigation relift pumping facilities (as proposed, for example, in IECO's Upper Helmand Development Plan). Such uses may be added to forecasts when their specific requirements are identified.

Town (Residential) Electrical Energy Demand

General

A projection of town residential electrical energy

demand was made using as a guide data on consumption and family income from Jalalabad. This area with an ample supply of electricity was selected as the 'correlation' area in order to estimate potential residential demand use in the Kajakai Service area under unrestricted supply conditions. A survey of 40 families in Jalalabad provided information on energy use and selected socio-economic characteristics. A comparison was made between annual family income and electrical energy consumption. The two variables were plotted. A straight line function was considered applicable and a regression line fitted by the least square method. A graph of the plotted data and the regression line is shown in Exhibit VI. The value of 'b', the coefficient of regression is 0.033, indicating that an annual increase in per capita income of 1,000 Afs would be expected to lead to an annual per capita consumption increase of 33 kWh.

Residential Demand Projections

In the Kajakai Service Area the residential demand projection is based on the following assumptions.

(1) For the Upper Helmand towns and Kanadahar the average annual population growth rates for the period 1354-1369 are 4.0 and 2.5 percent, respectively (Appendix Table 14). The higher growth rate for the Upper Helmand reflects the planned development programs in the area including completion of the new paved road connecting Lashkar Gah with the main Herat - Kandahar-Kabul highway. (Table 14).

(2) The degree of electrification or the percent of the total town population having electrical service available. The rate of increase is based on the projected number of connections developed in Section III.

(3) The projected increase in average per capita real income of town families is estimated at 2.0 percent annually. This is based on data contained in the Lashkar Gah Demographic Survey (Reference 6).

(4) Correlation of per capita income and kwh demand by assuming that the same income-energy relationships applies in the Kajakai towns as that derived from the Jalalabad survey data.

Comparison of Alternative Residential Energy Projections

A comparison of the per capita income and energy projections, shown in detail in Appendix Tables 15 and 16, with the projection based on an adjusted trend analysis developed and presented in Section III is summarized below.

	Upper Helmand		Kandahar		Total	
Year	Adjusted* Trend	Income** Energy	Adjusted* Trend (MWH)	Income** Energy	Adjusted* Trend	Income** Energy
1354	3,683	2,100***	5,000	4,300	8,638	6,400
1359	5,300	3,600	26,000	16,000	31,300	19,600
1364	6,800	6,800	34,600	26,000	41,400	31,400
1369	8,000	8,000	40,000	36,700	48,000	44,700

The two projections differ significantly in the 1354-1364 period. The major difference is due to the projected consumption level in the presently rationed Kandahar area. The projection based on the per capita income and energy relationship developed from Jalalabad data indicates a lower level of utilization in the 1356-64 period than the adjusted trend analysis developed in Section III. Also, the financial survey data on consumer ability and willingness to pay, shown later, suggests a lower utilization level than that implied by the adjusted trend projections. The Jalalabad cross-sectional relationships however, can not fully account for the more dynamic factors affecting future consumption in an area such as Kandahar having, at present, an unmet demand for energy. For the 1359-1369 period the two projections

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* Adjusted Trend projection developed in Section III.

** Family Income and energy consumption correlations based on the Jalalabad survey data. Value of the regression coefficient 0.033 times the projected per capita income is used to estimate <u>future</u> per capita electrical energy (kwh) usage.

*** The present (1354) Upper Helmand estimate derived from per capita sample values which excluded high consumption enclaves in Lashkar Gah. This accounts for part of the difference between trend and the lower figure. See Appendix Tables 15 and 16.

provide a range of consumption levels that may be used to compare costs and revenues associated with alternative rates of system expansion. Several years of actual experience will be needed to determine how fast the presently electrified and new customers will use electricity once the rationing in the area is eliminated.

For 1369 (1990) the two projections differ, in total, by less than seven percent. The terms of reference call for an electrification plan of the area showing the electric lines and facilities required to economically provide twice the requirements for the year 1369 (1990). Over the longer term the two projections are consistant with one another and essentially call for the same system capacity to serve the town (residential) loads.

Industrial Energy Projection

The projections of industrial energy consumption is based on (1) survey data of energy demand of existing plants and (2) information provided by the Ministry of Planning on new plants scheduled for construction in the area. Of the major existing plants both the cotton ginning plant at Lashkar Gah and the food processing plant at Kandahar will be continuous customers of Kajakai power when it becomes available (In 1356). The plant presently use diesel driven generators as a supplemental power source.

For new industries the Ministry of Planning provided information on the kinds of plants to be located in the area, the energy demand and estimated start up dates. The major new plants include a cotton ginning plant at Girishk and a cement and a textile plant in Kandahar. The adjusted trend analysis includes an allowance for addition growth in industrial energy consumption as the area's industrial base expands in the future. The details of the adjusted trend projections are included in Section III.

Commercial, Bazaars, Non-Metered Loads and Losses

Projections of energy consumptions in these categories is based on an adjusted trend analysis, details of which are included in Section III.

Comparison of Town Family Income and Energy Costs

For the draft report the economic and financial analysis also includes a financial analysis of the town family income

and energy cost, both for the electrified and non-electrified households. The primary consideration of the financial analysis is to (1) estimate the present total energy cost of the electrified families, the percent of family income spent for energy, and the ability and willingness of the electrified families to utilize electricity and (2) estimate the present total energy cost of the non-electrified families and their ability and willingness to connect to the system when Kajakai power becomes available.

The present system is limited in its ability to supply additional power. Rationing exists, especially in Kandahar, and customer requests for additional energy provides the basis for projecting aggregate increase in energy and power demand. The energy use survey of town households in the Kajakai Service area provides financial data on consumers' experience in using and paying for energy, both the presently electrified households and those expected to be added to the system in the future.

A survey of town families in the Kajakai Service Area was made with the assistance of the WAPA personnel in Kandahar and Lashkar Gah. Both the presently electrified and non-electrified families were included in the survey and information collected on family size and income, energy use and costs, and the ability and willingness to pay for electricity. A total of 100 electrified families were selected on a random basis from a list of customers provided by WAPA. For non-electrified customers a random sample of 100 was taken from different locations in each area. The urban areas surveyed include Kandahar, Lashkar Gah, and Girishk.

Survey Results: Non-Electrified Families

For the 40 families* surveyed in Lashkar Gah and Girishk the sample data indicates that energy costs averaged 11.4 percent of average family income. The average family income for the two areas and the total non-electrical energy costs are distributed as follows:

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* Non-electrical energy costs for Kandahar are not available.

	Afs	Percent
Annual Family Income (Lashkar Gah and Girishk only)	52,843	100
Annual Energy Costs		
Wood	4,150	7.9
Kerosene	1,684	3.2
Other (Battery)	164	0.3
	6,000	11.4

Non-electrical energy cost for town households is significantly higher than that of the farm families (11.4% versus 3.7% of the average family income) reflecting both greater levels of consumption and the cost of purchased supplies.

A social and economic survey of Lashkar Gah* in 1347 indicated that 9.6 percent of the total urban family expenditures was for fuel and light. The non-electrified families are incurring relatively high costs for using present energy sources and as a percent of income exceeds levels recorded in the surveys of other countries as reported in Appendix Table 8.

The surveyed families in the three urban areas of Laskar Gah, Girishk, and Kandahar indicated a willingness to pay an average of 2,000 Afs. for the connection cost. This averages 4.4 percent of annual family income. For the monthly electrical energy costs the surveyed families indicated they could pay 3120 Afs per year, which represents 6.8 percent of the average family income. Survey data indicates that electricity would replace all of the kerosene and battery usage and some of the wood. However, total family expenditure would still exceed ten percent and probably average 11 or 12 percent during the initial years of electrification. The evidence suggests that partial conversion to electricity will not lower the initial cost for the average family. The incentive to convert will be based on the convenience and reliability provided by electricity with the family's total energy cost remaining at approximately the same level as before - at least during the initial years they are connected to the system. Appendix Table 17 shows the detailed results of the survey.

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* Bibliography Reference 6.

Survey Results: Electrified Families

For the electrified families the survey results show that non-electrical energy sources still are an important component of the total energy cost, averaging 8.4 percent of family income. Annual electrical energy consumption averaged 1,433 kwh per family in Lashkar Gah and Girishk and 813 Kwh in Kandahar, reflecting rationing and possibly the higher kWh cost in the latter area.* The annual electricity bill averaged 3.3 percent of family income in Lashkar Gah and Girishk and 5.0 percent in Kandahar. Total fuel and light cost for all three areas averaged 12.6 percent of annual family income. As with the non-electrified families this exceeds levels recorded in other countries (Appendix Table 8). Appendix Table 18 shows the survey results. A summary is presented below.

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* Unit (kwh) cost difference is based on WAPA's present policy of charging 1 Afs. per kwh for Hydro and 3 Afs per kwh for thermal generated power. Rationing has obscured the influence of the higher price in Kandahar.

ELECTRIFIED TOWN FAMILIES
SUMMARY OF SURVEY RESULTS RELATING AVERAGE
ANNUAL FAMILY INCOME AND ENERGY COSTS

	Lashkar Gah and Girishk (Afs)	Percent	Kandahar (Afs)	Percent	Average Three Areas (Afs)	Percent
Annual Family Income	43,374	100	48,561	100	45,968	100
Energy Costs						
Non-electric	3,754	8.7	3,943	8.1	3,848	8.4
Electric	1,433	3.3	2,439	5.0	1,936	4.2
Total	5,187	12.0	6,382	13.1	5,549	3.4
Connection Cost (Excludes Wiring Cost)	1,598	3.7	1,500	3.1	1,549	3.4
Original Cost of Electrical Appliances presently in use	1,260	2.9	1,414	2.9	1.337	2.9

The relative advantage of using electricity is obscured by the continued heavy reliance on wood and kerosene which for town households are high cost sources. This is especially true for the Upper Helmand areas which were relatively free from rationing and have a 1 Afs per Kwh rate. Use of electricity has not lowered the consumer's total energy cost due, in part, to the initial connection and wiring costs required. The survey data indicate that town households should not have the same economic incentive as farm households for continuing with non-electric energy sources once electricity is available; however, wood burning units with multiple purpose capability (cooking, space and water heating) make direct cost comparisons difficult. In some cases consumer preference to use wood for cooking is based on non-economic factors (e.g. taste preference for cooking rice and baking bread). It appears that with the continuing heavy reliance on these sources, electricity must provide clear cut cost advantages before significant increases in use will take place.

Town Electrified Versus Non-Electrified Families

The average annual family income for electrified and non-electrified families is approximately the same (46,000 versus 45,900 Afs). Total fuel and light cost as a percent of family income also is similar (12.6 versus 11.4 percent). For the electrified families, wood and kerosene continues to be a major component of the total energy cost (67 percent). Physical proximity of the existing facilities and willingness to pay the initial connection and wiring costs are the primary reasons for families having electricity at present.

The energy survey results are somewhat inconclusive regarding relative cost advantages of converting to electricity and for increasing usage once conversion takes place. Costs of the present non-electrical sources are relatively high for town families and will remain high cost sources in the future. Town residential consumers should have the ability to pay for the additional quantities of electricity as projected in this section (detailed Kwh projection shown in Appendix Tables 15 and 16) provided electricity is used to replace the traditional non-electric energy sources. Non-electrified town families indicated a willingness to pay an average of 2,000 Afs for connection costs and 3,000 Afs annually for electricity. These amounts represent 4.4 and 6.8 percent of the average family income respectively. The initial primary use of electricity would be for lighting

with wood remaining as the source of energy for cooking and heating. The willingness to use and pay for more electricity will depend, in part, on the extent to which the non-electrical energy sources are perceived to be less efficient and/or more expensive. With a Kwh charge greater than 1 Afs it appears that for a significant number of town families, utilization of electricity could be curtailed due to (1) existing energy costs are relatively high and (2) the incentive to convert from the traditional non-electrical energy sources would be reduced.

Lower income consumers will need assistance in financing the initial connection and wiring costs. These costs average approximately 3,000 Afs. for a minimum installation (1,500 Afs each for connection and wiring). This study assumed the initial costs would be financed over a four-year period in developing annual cost estimates.*

Comparison of Farm and Town Family Incomes

Survey data on annual town family and the adjusted farm family incomes are summarized below:

Average Annual Family Income (000 Afs)

Town		Farm	
Non-Electrified	Electrified	Non-Electrified	Average Farm/Town Income Ratio
45.9	46.0	44.5	0.98

* Discussions with WAPA officials indicated a four to five year repayment period was being considered for the connection cost.

The 1347 demographic and economic survey of Lashkar Gah and surrounding areas estimated the annual town and rural family expenditures as follows:

Town Families (000 Afs)	34.9
Rural Families (000 Afs)	26.1
Average rural/town expenditures ratio	= 0.75

Statistical discrepancies may explain the apparent shift in relative income levels as recorded by the two surveys. Other relevant factors include (1) farm incomes in the Helmand Valley have, in fact, increased substantially since 1347 as data in Tables 1 and 2 indicate and (2) the farm families included in the 1354 FES and the supplemental energy survey excludes the Bazgars[1/], their families and farm labors.

The Bazgars comprised 40 percent of the total rural population in the Helmand Valley in 1349. In effect, the farm families surveyed and considered potential customers for electricity are in the higher income groups of the rural population. The Bazgar families with lower average incomes have not been included in the energy survey and are not considered potential customers for Kajakai power during the period covered by this study. The study results do indicate that a signficant segment of the rural population is on par with the average town family in terms of income level and ability to pay for system facilities. The main determinants of the actual consumption level will be the cost of providing service to the different areas and the repayment policies established by the operating agency. A summary of the energy survey data relating family income and energy use for the Town and Rural families is shown in Appendix Table 19.

Rural and Town (Residential) Projections

The methods used in projecting rural and town energy demands emphasize different factors for the following reasons:

(1) The rural population presently is without experience in using electricity and the cost of the major

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1/ Tenant farmers contributing no inputs other than their own labor and usually receiving one-fifth of the crop.

alternative source, wood, is relatively low. In addition to family income and willingness to pay considerations the cost of alternative sources was considered to be a critical constraint in projecting future demand for electricity in the rural areas.

(2) The present town energy use is influenced by several factors: family income levels, willingness to pay and cost of alternative sources, physical proximity to existing facilities and present supply restrictions. When Kajakai power is made available and existing supply restrictions lifted the longer term demand projections are expected to be heavily influenced by the consumer's accessibility to the system and family income levels. The family income-energy use relationships developed from the Jalalabad survey was the primary tool used in projecting town residential demands.

Price-Demand Relationships and Economic Benefits

The effect of price on the rural demand for electrical energy was estimated by varying the Kwh rate and relating total energy cost to the benchmark figure of 6 percent of family income as discussed previously. For town families present energy costs, both for electrified and non-electrified families are relatively high. As a percent of family income it varies between 10 and 13 percent and exceeds the level recorded in consumer expenditures surveys of selected countries as shown in Appendix Table 8. It was not possible to derive a benchmark figure comparable to that established for the rural category from these data. In addition, families presently electrified in Lashkar Gah, Girishk and Jalalabad, paying the relatively low hydro based rate of one AFS per Kwh, continue to use significant amounts of non-electrical energy (in monetary term between 60 to 70 percent of the family's total energy expense). Kandahar, with a thermal based rate of three Afs per Kwh has severe supply restrictions and the effect of the higher rate on consumption has been obscured. The projections of non-rural electrical energy consumption presented in Section III assume a continuation of the present hydro based rate of one Afs per Kwh.

From data and analysis of the rural electrical energy demands, order of magnitude estimates of the effect of price on demand for the non-rural categories may be derived. These estimates provide the bases for calculating system sales revenues and project direct benefits.

The implied price elasticity coefficients for the rural category for the years 1359, 1364 and 1369 are -0.8, -0.9 and -0.5, respectively.* The rural demands will, therefore, change proportionately somewhat less than price during the 1359-1364 period. As farm income grows demand is expected to be less sensitive to price increases (within the ranges assumed herein) in 1369 and after. For the town residential, commercial and bazaars categories it is assumed that the average of the rural coefficient would apply over to 1359-1369 period (i.e. E=-0.73). Town residential total energy costs are relatively high and with a Kwh charge greater than one Afs it is assumed that electrical consumption would be reduced on the average 7 percent for each 10 percent increase in price.

For the industrial category, the system will provide an adequate and reliable source of power the demand for which is assumed to be relatively less sensitive (inelastic) to a price change than the other non-rural categories given the price ranges used herein. The price elasticity coefficient for the industrial category is assumed to be equal to -0.5 over the 1959-1939 period.

Given the assumption outlined above the price, quantity and revenues relationships for the rural and non-rural categories 1359, 1364 and 1369 are estimated as follows:

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* From page IV-15 for 1359; Quantity change = 8383 ÷ 10222; Price change 2 ÷ 2; Quantity divided by Price = .82 ÷ 1.0 or E = 0.82.

ELECTRICAL ENERGY DEMAND (GWH), SYSTEM REVENUES (MILLION AFS)
AT KWH COST OF ONE AND THREE AFS BY CATEGORY, 1359 TO 1369

	Rural			Town*			Industrial			Total		
	1359	1364	1369	1359	1364	1369	1359	1364	1359	1359	1364	1369
One Afs/Kwh												
Energy (Gwh)	14.4	27.5	38.5	55.1	72.4	87.0	67.0	121.0	152.5	136.5	220.9	278.0
Revenues (10^6 Afs)	14.4	27.5	38.5	55.1	72.4	87.0	67.0	121.0	152.5	136.5	220.9	278.0
Three AFS/Kwh												
Energy (Gwh)	6.0	10.0	23.9	26.2	33.7	40.5	40.2	72.6	91.5	72.7	116.3	155.9
Revenues (10^6 Afs)	18.1	30.1	71.7	78.7	101.0	121.4	120.6	217.8	274.5	218.1	348.9	467.7

* Town includes Residential, Commercial and Bazaars

Electrical energy use and system sales revenues could vary significantly within the price ranges assumed herein. Due to the implied 'inelastic' nature of demands, total system revenues would increase with the higher Kwh rate. Reduced consumption may affect capacity requirements and system average unit cost. The exact nature of these changes (e.g. - on peak demands) is not known due to the lack of firm data on the actual consumer response to price changes. The price elasticity estimates must be used with caution for this reason. Present experience in using electricity in the non-rationed part of the project area and in the correlation area of Jalalabad has been with a relatively low Kwh price. In all the urban areas studied, household energy costs are relatively high and non-electrical energy is a significant component of the total cost.

Project benefits may be measured as being equal to the system sales revenues. Additional benefits attributed to savings over present energy costs have not been calculated. The multiple purpose nature of the non-electrical energy units used for cooking, space and water heating make direct cost comparisons difficult. Estimated system sales revenues based on a Kwh rate of one and three Afs are given below:

Afs/Kwh	Year 1359	1364	1369
	(million Afs)		
1	136.5	220.9	278.0
3	218.1	348.9	467.7

At the higher rate of three Afs per Kwh, total system revenues increase given the implied 'inelastic' nature of consumer demands. Benefit estimates using system sales revenues generated by the one and three Afs rate are not comparable due to the fact that (1) the higher rate, in effect, captures some of the theoretical consumer's surplus previously unaccounted for at the one Afs rate and (2) the higher rate leads to a reduction in electrical energy consumption and total consumer satisfaction. This loss in total benefits can be taken as being equal to the reduction in the area under the composite demand curve and may be approximated by the following formula:

$$\text{Total loss} = P_1 + P_2 \div 2\ (Q_1 - Q_2)$$

Using 1990 data as an example the values for P and Q and the benefit loss estimate are as follows:

P_1 = 1 Afs Q_1 = 278 Gwh

P_2 = 3 Afs Q_2 = 156 Gwh

Total loss = (1+3) ÷ 2 (278 - 156) or 244 million (Afs).

With gross system rate revenues adjusted for this loss the benefit estimates of the one and three Afs rate for 1359, 1364 and 1369 would be:

		1359	1364	1369
			(million Afs)	
One Afs:	Sales revenues and benefits	136.5	220.9	278.0
Three Afs:	Sales revenues	218.1	348.9	467.7
	- Losses	-127.6	-209.2	-244.2
	Adjusted benefits	90.5	139.7	223.5

The lack of firm data on consumer response to price changes precludes more accurate calculation of direct project benefits however, the analysis does support the assumption that total consumer satisfaction and direct project benefits are greater at the lower rate. An evaluation of net project benefits would require more detailed data on consumer response to price change and cost estimates for providing system service throughout the Kajakai Service Area.

Shadow price adjustments have not been made. Use of major appliances is not prevalent in the project area and the initial use of electricity will be for lighting and for small heating and cooking units the costs of which are relatively inexpensive (Appendix Table 20), Also, the free market foreign exchange rate and the official rate are approximately the same. For this study the official foreign exchange rate of 55 Afs per U.S. dollar was used. The IMF office in Kabul indicated that the bazaar (free market) rate and the central bank rate were within a fraction of each other during the period immediately preceeding the beginning of this study. Labor costs adjustments were not considered and will require more detailed information on labor availability and demand in the project area.

Conclusions

The rural demand for electricity is based on an assessment of farm family income, energy costs, survey information on willingness to pay and estimates of energy expenditures levels existing in other Asian Countries. The present use of electricity in the rural areas is negligible and the cost of non-electrical energy sources relatively low. Farm families have indicated a desire to use electricity with the initial use primarily for lighting. Demand projections for the period 1359-1369 consider the total cost of using electricity including the connection, wiring and appliance costs. Survey information from the correlation area, Jalalabad, provided estimates of the consumption level and total cost relationships. These were compared to projected farm incomes in estimating future potential demands.

Projections of future rural demands were based on two prices for electricity, one Afs and three Afs per Kwh. The impact of price on demand was significant. The rural demand estimates for the 1359 to 1369 period are:

	One Afs/Kwh	Three Afs/Kwh
	(MWH)	
1359	14,413	6,030
1364	27,474	10,031
1369	38,488	23,889

Other potential electrical energy demands, mainly farm production use, were not included in the rural demand projections. Farm production uses are expected to be negligible within the time frame of this study. Rural based agro-industrial demands and village and irrigation and drainage district demands for specific purposes (e.g. village water systems and irrigation relift pumping facilities) will need to be identified in more detailed studies and incorporated into the overall rural demand projects.

The town residential projections were made for the main urban areas of Lashkar Gah, Girishk and Kandahar. The analysis of town residential demands was based on data from the Jalalabad survey and used family income-energy use correlations as the primary tool for projection purposes. Present town family energy costs are relatively high when compared to the rural family's expenditures level. The average town family annual energy costs ranged between 10 and 13 percent of the annual family income compared to 3 to

4 percent for the average rural family. The town families presently with electricity also continued to rely heavily on non-electrical energy sources which accounted for 60 to 70 percent of the family's total energy cost. Town families indicated a desire and willingness to pay for and take electricity, however the exact trade-off between electricity and other energy sources is difficult to determine with the present information. Use of multiple purpose wood burning units for example, make direct cost comparisons difficult. Electricity must provide some clear advantages either in terms of cost savings and/or reliability and convenience before increased use will take place.

Electrical energy demands in other categories - industrial, commerical, bazaars, were based primarily on the adjusted trend analysis of Section III. Industrial demand projections also relied heavily on information provided by Government planning ministries and expansion plans outlined by experts associated with the operations of specific industries located in the project area.

An order of magnitude estimate of direct project benefits for all categories may be derived by using as a guide the price-demand relationships derived for the rural category. Price elasticity coefficients were assumed for the town residential, commercial, bazaar and the industrial categories. The estimates of system sales revenues for all categories for the 1359 to 1369 period are:

Afs/Kwh	Year 1359	1364	1369
	(Million Afs)		
1	136.5	220.9	278.0
3	218.1	348.9	467.7

It is difficult to compare direct project benefits using system sales revenues based on the one and three Afs per Kwh rate. The higher rate reduces electrical energy consumption and total consumer satisfaction and, in effect, quantifies part of the theoretical consumer's surplus not quantified with the one Afs rate. Total consumer satisfaction and direct project benefits is assumed to be greater at the lower rate.

Benefits associated with cost savings from using electricity were not calculated. More reliable data on the technical efficiencies and cost ratios of electricity and non-electrical sources appropriate for use in Afghanistan are needed for this analysis.

Financial assistance, especially for the lower income families should be considered to reduce the initial cost for connection, and wiring which, for a minimum installation would be approximately 3,000 Afs (1,500 Afs each for the connection and wiring). The study assumes these initial costs could be amortized over a five year period at eight percent interest. WAPA officials indicated financial assistance for connection cost are presently being considered.

Both rural and town families have demonstrated a potential demand for electricity. A large segment of the rural population have income levels comparable to the average town family. Rural communities, however, are scattered throughout the Kajakai Power Survey service area. The cost of serving the low density rural population will be relatively high and consideration should be given to a staged expansion program in the rural areas. For this study Rural Demand Areas B and C in the Upper Helmand Valley were considered to be subareas that could be included in the initial phase of a staged expansion program. These subareas which include Seraj, Central Girishk, Nowzad, Nadi Ali, Marja and Shamalon have, at present approximately 55 percent of the total farms in the Upper Helmand Valley. The actual level of consumption will depend, in part, on the cost of service and the government pricing policies adopted.

This Section IV describes in detail forecast of rural electrical energy demand and the price elasticity of demand. Next a comparison is made of the forecast of town (residential) electricity demand, made by the adjusted trend method discussed in Section III, with the Income-Electricity Demand correlations. An analysis is then further made of the relationship of electricity consumption forecasts for the rural and the town areas. Finally, an order of magnitude estimate is made of the direct economic benefits resulting from electrification.

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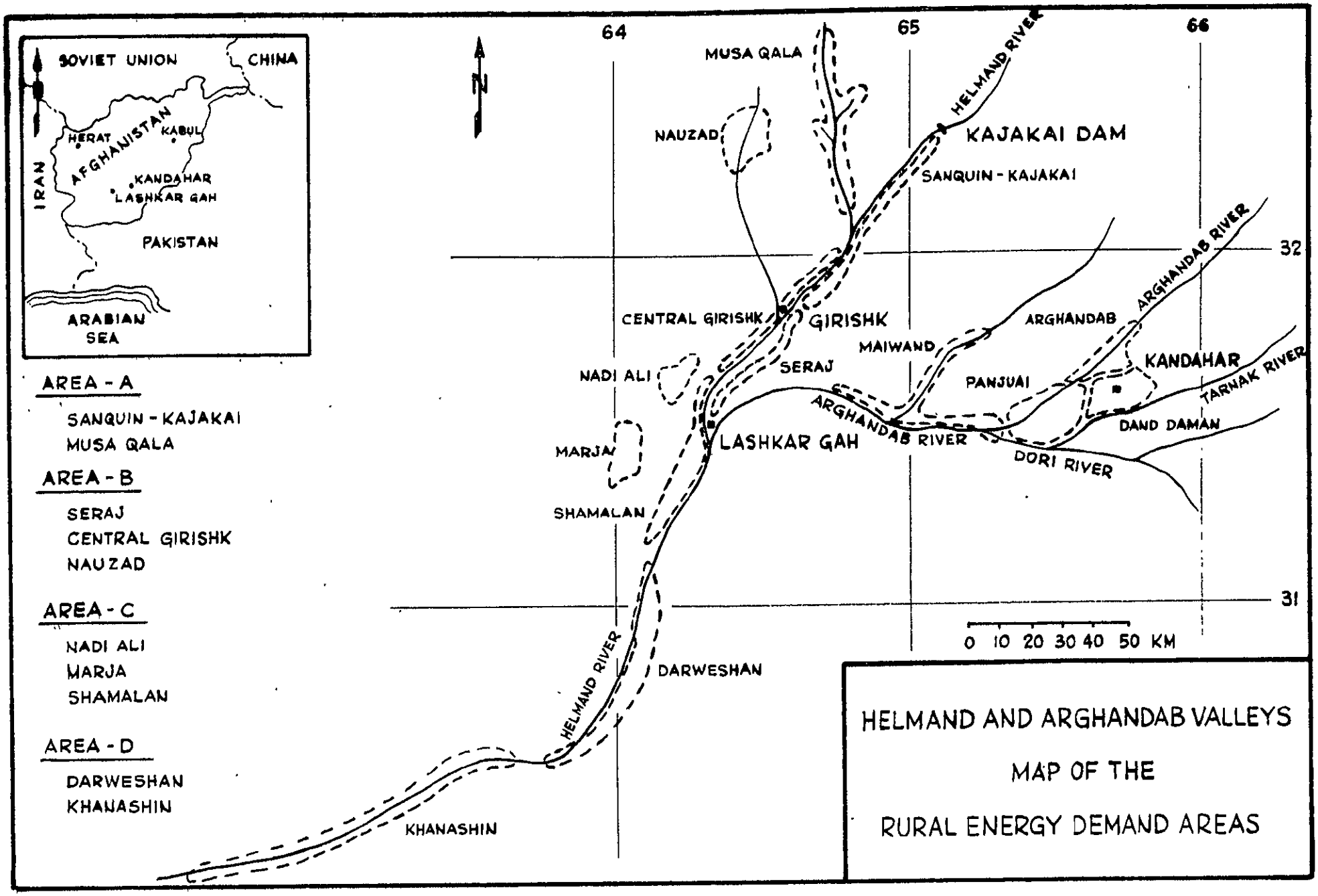
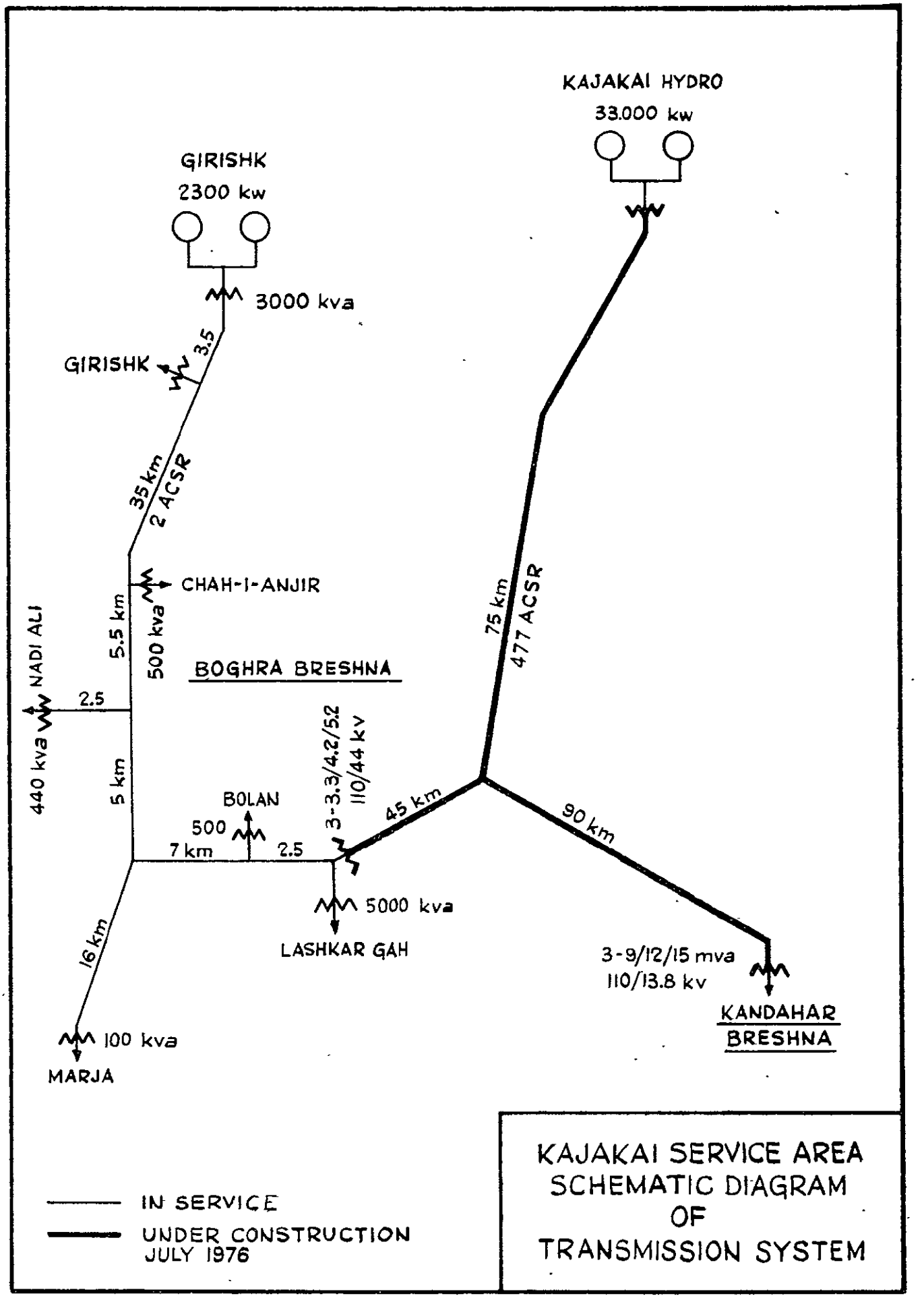


HELMAND AND ARGHANDAB VALLEYS
MAP OF THE
RURAL ENERGY DEMAND AREAS

EXHIBIT I

EXHIBIT II


KAJAKAI HYDRO
33.000 kw
GIRISHK
2300 kw
3000 kva
GIRISHK
3.5
35 km
2 ACSR
CHAH-I-ANJIR
5.5 km
500 kva
NADI ALI
BOGHRA BRESHNA
2.5
440 kva
5 km
3-3.3/4.2/5.2
110/44 kv
BOLAN
500
7 km
2.5
45 km
75 km
477 ACSR
90 km
5000 kva
LASHKAR GAH
16 km
100 kva
MARJA
3-9/12/15 mva
110/13.8 kv
KANDAHAR
BRESHNA
IN SERVICE
UNDER CONSTRUCTION
JULY 1976
KAJAKAI SERVICE AREA
SCHEMATIC DIAGRAM
OF
TRANSMISSION SYSTEM

HARZA OVERSEAS ENGINEERING COMPANY

LASHKAR GAR, AFGHANISTAN

ENERGY SURVEY FIELD SCHEDULE

FARM HOUSEHOLDS*

Householder's Name _____ Interviewer's Name _____
Date _____

Village Code No. _____ Schedule No. _____

Village _____ HAVA Service Area _____ Province _____

A. Electrified Farm Households (if any)

1. Date connected _____
   Cost of connection _____ Afs.

2. Present level of consumption _____ Av. KWH/month/yr.

3. Electricity presently used for household purposes:
   a. lighting _____ b. heating _____
   c. cooking _____ d. other _____

4. Type and cost of electrical appliances used in household:

Type of appliances	Original Cost No.	Power	Price	Date purchased (yr.)		
a. Light						
b. Stove						
c. Heater						
d. Radio						
e. Boiler						
f. Other						

B. Electrified and Non-Electrified Farm Households

5. Other (existing) sources of energy presently in household use:

Purpose	Type	Source of Supply	Cost per Unit	Quantity used Av./mon.	Reasons for Using
A. Light	A. Wood	A. Own Farm			A. Only source
B. Cooking	B. Kerosene	B. Purchase			B. Convenience
C. Heating	C. Gas	C. Other			C. Lowest Cost
D. Other	D. Battery				
	E. Crop residue				
	F. -----				
	G. Other				

6. Would you be willing to use electricity for some of the above purposes?
YES _____ NO _____

If yes, for what purpose (most important first):

1. _____ 2. _____ 3. _____ 4. _____

Under what conditions:

a. When the connection cost is lower _____
How much connection cost can you afford _____

b. When a more reliable supply of electricity is made available _____

c. If electricity is cheaper than present sources _____

d. Were I able to purchase appliances _____

e. Other (specify) _____

7. What is the maximum amount that you could afford to pay each month for household use electricity _____ Afs.

8. Quality of house:

a. No. of rooms _____
b. Estimated value of house _____ Afs.
c. Is your house: Own _____ Garow** _____ Rent _____
d. Other facilities on the house (e.g., water, etc.) _____

9. Estimated family living expenses by major category:

a. Food	_____	Afs./yr.	b. Clothing	_____	Afs./yr.
c. Housing	_____	" "	d. Medicine	_____	" "
e. Ceremonies	_____	" "	f. Education	_____	" "
g. Travel	_____	" "	h. Other	_____	" "

10. Present use of electricity for farm (Productive uses):

a. Farm machinery - power for crop cutting, drying, threshing, etc.
Specify uses, _____, _____, _____

b. Irrigation pumping _____

c. Other(s) Specify _____

11. Indicate relative importance of the above uses A,B,C.

Most important _____
Second Most Important _____
Third Most important _____

12. Size of village:

a. No. Families _____
b. No. of people _____

13. Distances of village from nearest urban center:

    a. Lashkargah _____ km.
    b. Girishk _____ "
    c. Kandahar _____ "

14. What change will electricity bring to your family life and farming operation?

_____
_____
_____
_____
_____
_____

* Used as a supplement to Farm Economic Survey.

** Garow - local custom regarding land and indebtedness. When a landowner's debt reaches a certain level, he is obliged to transfer special title and use of an appropriate amount of land to his creditor. The only rights retained by the original owner are redemption rights for himself and his heirs.

HARZA OVERSEAS ENGINEERING COMPANY

LASHKAR GAR, AFGHANISTAN

ENERGY SURVEY FIELD SCHEDULE

MAJOR INDUSTRIAL LOADS

1. Name of Plant _____

2. Type of Business _____

3. Electrical Supply Data

3.1 If diesel or gas driven auxiliary generators were used in 1354 what was their total capacity _____ kva.

3.2 Plant Energy Use

Billing periods (months)	Purchases from in Breshna in 1354 1 kwh	Output of diesel or gas driven auxiliary generators in 1354 2 kwh	Total Electrical Consumption in 1354 1 + 2 kwh	In each 2 month period there were about 61 days or 1464 hours. How many hours did the plant operate in each of the 6 periods of 1354 hours
H,S				
J,S				
A,S				
M,A				
K,J				
D,H				
TOTAL				

3.3 Future Plans

3.3.1 (a) Will the total electrical requirements of the plant be taken from the Breshna when energy from Kajakai becomes available? YES___ NO____

(b) If yes, are the transformers and other facilities to receive Kajakai power available now? YES___ NO____

(c) If no, when could the necessary facilities be available? _____Months

3.3.2 (a) At what capacity did your plant operate in 1354? _____% of maximum.

(b) If it did not operate at 100% capacity in 1354, in what year do you anticipate full capacity will be reached? _____

(c) If it did not operate at 100% in 1354, what will be its total electrical load when it does?

Months	kwh
H,S	
J,S	
A,S	
M,A	
K,J	
D,H	
TOTAL	

3.3.3 (a) Do you anticipate increasing the size of your present plant? YES___ NO____

(b) If yes, in what year? _____ and by how much? _____

3.3.4 (a) Is there any other mechanical or heating process in the plant that will be changed to an electrical process after Kajakai is operating? YES___ NO____

(b) If there is, what would its electrical consumption have been in 1354?

Months	kwh
H,S	
J,S	
A,S	
M,S	
K,J	
D,H	
TOTAL	

4. Economic Data

4.1 Ownership: Private____ Public____ Number of employees_____

Length of time at present location_____

4.2 Production and Value of Principal Products

4.2.1 Product #1 _____

Unit of measuring production _____
(bales, meters, kg, liters, boxes, or ?)

Year	Total Production in units	Value in Afs. Unit Value	Total Value
1350			
1351			
1352			
1353			
1354			

What percentage of the cost of this product was electrical energy in 1354? _____%

4.2.2 Product #2 _____ Unit of measuring production _____

Year	Total Production in units	Value in Afs. Unit Value	Total Value
1350			
1351			
1352			
1353			
1354			

What percentage of the cost of this product was electrical energy in 1354? _____%

4.3 Sales in 1354

4.3.1 Domestic _____%

Within the HAVA area _____%
Outside the HAVA area _____%
Which Provinces, % _____

4.3.2 Foreign _____%

Which countries _____
Average unit value of production exported _____Afs.

4.4 Auxiliary Power Sources

4.4.1 Capital Costs

Diesel or gas engines _____Afs.
Generators _____Afs.
Switchgear, transformers _____Afs.

4.4.2 Annual Costs in 1354

Diesel or gas engines _____Afs.
Generators _____Afs.
Switchgear, etc. _____Afs.
Cost of operation,
Maintenance & labor _____Afs.
Cost of fuel _____Afs.

HARZA OVERSEAS ENGINEERING COMPANY

LASHKAR GAR, AFGHANISTAN

ENERGY SURVEY FIELD SCHEDULE

TOWN HOUSEHOLDS

Householder's Name _____ Interviewer's Name _____
Date _____

1.a) Town _____
b) Address _____
c) Province _____

2.a) Age of head of household _____ Years
b) Years in school of head of household _____
c) Years lived in town _____
d) Years lived in this house _____

3.a) Household size _____
b) No. of married men _____

4.a) Males 0-12 years old _____
b) Males 13 and older _____
c) Females 0-12 years old _____
d) Females 13 and older _____

5.a) No. of family members working _____
b) No. not working but looking for work _____

6.a) Present occupation of head of household _____
b) Present occupation of other family members working
1) _____ 2) _____
3) _____ 4) _____

7. During the last twelve months what was the average take home salary (wages or income) of the family members working?

Head of household: Average monthly _____ Afs.
Total for year _____

Other family members working:

1) Average monthly _____ Afs. Total for year _____ Afs.
2) Average monthly _____ Afs. Total for year _____ Afs.
3) Average monthly _____ Afs. Total for year _____ Afs.
4) Average monthly _____ Afs. Total for year _____ Afs.

8. What was the total family take-home income in the past twelve months?
_____ Afs.

9. Date of electrical connection _____

10. Cost of electrical connection _____ Afs.

11. Present level of electrical consumption
_____ kWh/Yr. (from billing record)

Previous year electricity consumption _____ kWh/Yr.

12. Electricity presently used for:

1) Lighting _____ 2) Cooking _____
3) Heating _____ 4) Other (specify) _____

13. Type and cost of electrical appliances used in the household:

Type of Appliance (Light, stove, heater, radio, etc.)	Original Cost (Afs.)	Date Purchased (Year)

14. Other (existing) sources of energy presently in household use:

Purpose Used	Type	Source of Supply	Cost per Unit	Quantity used Per Year	Reason for Using
A. Light B. Cook C. Heat D. Other	A. Wood B. Kerosene C. Gas D. Battery	A. Purchase B. Other			A. Only Source B. Convenience C. Lowest Cost D. Other

15. Would you be willing to use electricity for some of the above purposes?
YES _____ NO _____

If yes, for what purposes (most important first)

1) _____ 2) _____ 3) _____ 4) _____

Under what conditions?
a) When electricity becomes more reliable _____
b) If electricity is cheaper than present sources _____
c) Were I able to purchase appliances _____
d) When the connection cost is lower _____
e) Other (specify) _____

How much connection cost can you affort to pay? _____ Afs.

16. What is the maximum amount you could afford to pay each month for electricity? _____ Afs.

17. Quality of house:
    a) Number of rooms _____
    b) Estimated value of house _____ Afs.
    c) Do you own the house or rent? _____
    d) Other facilities in the house (water, etc.) _____

18. Estimated family living expenses by major category:
    a) Food _____ Afs./Yr.
    b) Clothing _____
    c) Housing _____
    d) Utilities _____
    e) Medical _____
    f) Transportation _____
    g) Ceremonies _____
    h) Other _____

19. Did you borrow money last year?
    a) Yes _____ No _____
    b) If yes, for what purposes? _____
    c) If yes, from what source?
       1) Friends of family or relatives _____ 2) Banks _____
       3) Rich people _____ 4) Other _____
    d) If yes, how much did you borrow? _____ Afs.

20. What change will an increased supply of electricity bring to your family life?

_____
_____
_____
_____
_____

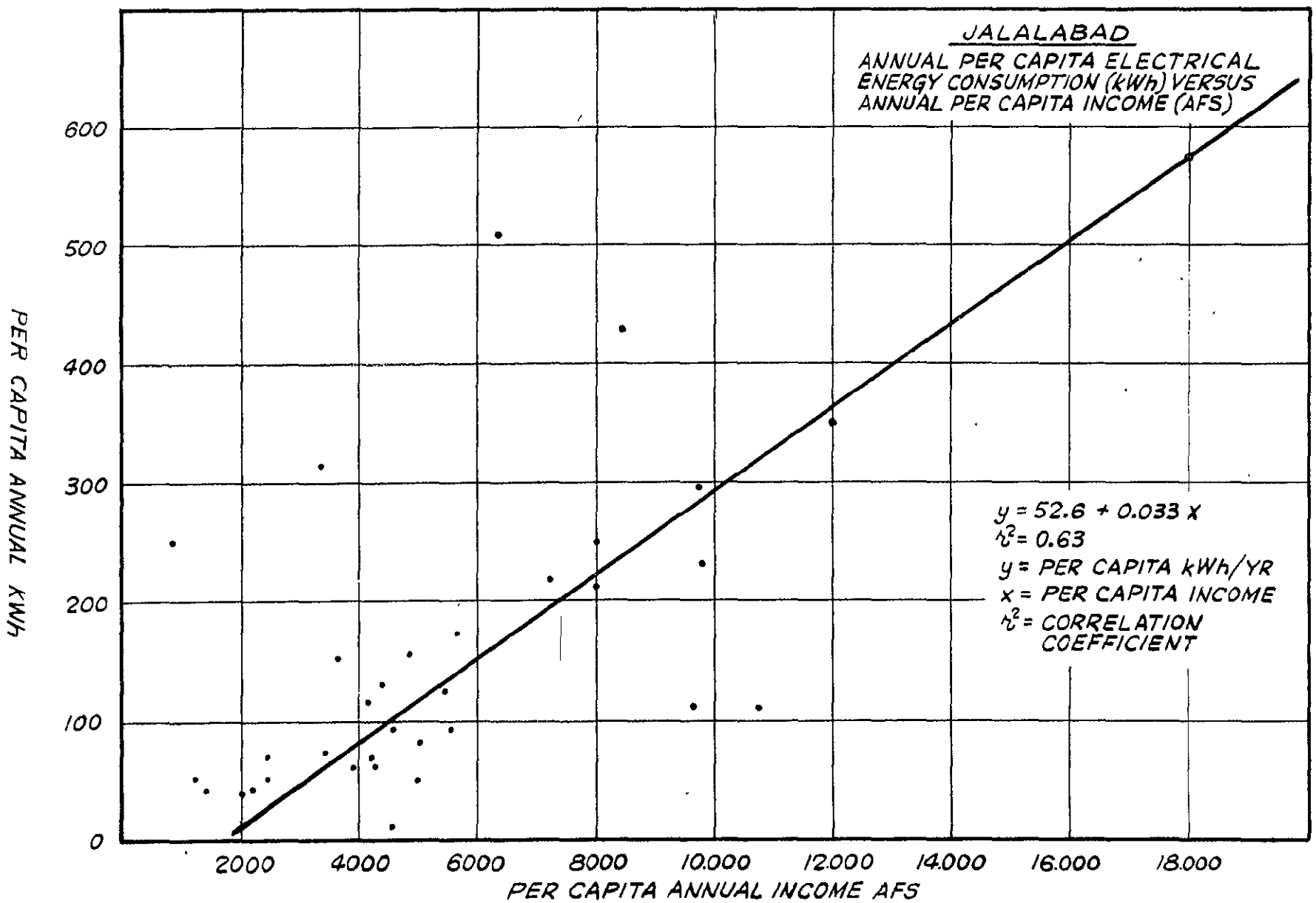
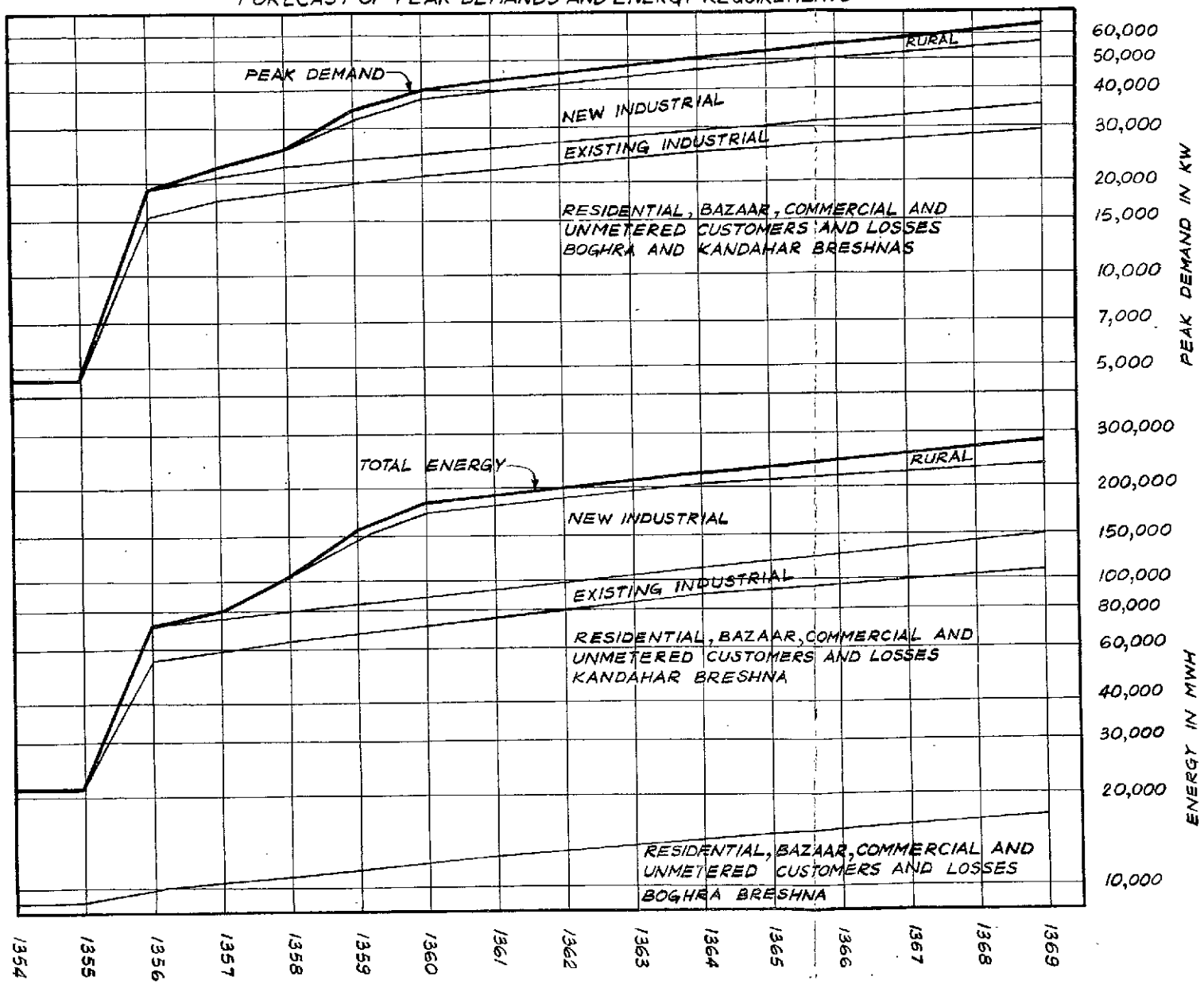

JALALABAD
ANNUAL PER CAPITA ELECTRICAL ENERGY CONSUMPTION (kWh) VERSUS ANNUAL PER CAPITA INCOME (AFS)
y = 52.6 + 0.033 x
r² = 0.63
y = PER CAPITA kWh/YR
x = PER CAPITA INCOME
r² = CORRELATION COEFFICIENT
PER CAPITA ANNUAL KWh
0
100
200
300
400
500
600
2000
4000
6000
8000
10.000
12.000
14.000
16.000
18.000
PER CAPITA ANNUAL INCOME AFS

EXHIBIT VI

EXHIBIT VII

KAJAKAI SERVICE AREA
FORECAST OF PEAK DEMANDS AND ENERGY REQUIREMENTS



Land in Wheat, Corn and Cotton by Areas, and Total
Helmand Valley - (Hectares) 1349 and 1353

Area	Wheat 1349 Local	Wheat 1349 Improved	Wheat 1353* Local	Wheat 1353* Improved	Corn 1349 Local	Corn 1349 Improved	Corn 1353* Local	Corn 1353* Improved	Cotton 1349	Cotton 1353
Nadi Ali	5,393	1,499	380	5,751	526	117	-	191	974	2,195
Marja	3,495	1,146	-	7,562	281	94	-	885	935	4,257
Shamalon	10,862	404	934	4,927	1,379	269	-	491	1,682	6,129
Darweshon	8,266	412	5,685	3,734	214	381	355	4	1,068	3,922
Khanishin	14,059	-	7,445	321	16	-	198	-	-	1,151
Seraj	8,059	-	4,100	575	539	-	39	-	262	1,058
Girishk	4,315	1,726	157	8,090	3,176	35	1,292	-	570	3,052
Sanguin-Kajakai	3,744	562	619	4,981	2,130	-	634	-	387	1,317
Mosa Qala-Zamin Dawar	4,756	42	1,687	2,246	637	-	420	10	127	726
Nowzad	2,306	-	2,455	154	145	-	302	-	-	135
Total	65,281	5,681	25,815	42,659	9,043	896	3,652	1,600	6,005	26,913

* Totals include other subareas listed separately in 1353 (Bolan, Ainak, Babaji).

Sources: 1349: FES 1349, Table 40 page 80.
1353: HAVA Dept. of Statistics March 1355.

APPENDIX TABLE 1

Value of Selected Crops for 1349 and 1353, by Service Areas
Helmand Valley (In 000 Afs)

Service Area	Wheat 1349	Wheat 1353	Corn 1349	Corn 1353	Cotton 1349	Cotton 1353	Total Crops 1349	Total Crops 1353	Percent Increase 1349-53
Nadi Aji	58,104	112,635	6,970	1,246	7,924	27,760	72,998	41,531	94
Marja	33,476	144,870	2,285	16,000	7,345	53,900	43,106	214,770	398
Shamalon	103,228	107,870	15,974	6,640	20,283	77,784	139,485	191,527	37
Darweshan	52,058	133,443	5,197	2,406	9,102	49,422	66,357	185,271	179
Khani-hin	33,349	93,579	253	3,267		11,259	33,602	108,105	222
Seraj	30,516	39,441	2,281	131	3,447	11,107	36,244	50,679	40
Sanguin-Kajakai	40,586	116,382	22,095	9,510	2,928	16,714	65,609	142,606	134
Nowzad	9,274	34,794	916	3,294		1,509	10,190	49,787	388
Total Helmand Valley	443,210	1,141,590*	86,589	64,208*	59,232	334,536*	514,257	1,540,334*	200

* Totals include other subareas listed separately in 1353 (Bolan, Ainak, and Babaji).

Sources: 1349 - From 1349 Farm Economic Survey, Table 42, p. 82.
1349 - From (1) Crop production statistics provided by HAVA Dept. of Statistics, March 1355, and (2) Farm Gate Prices used in 1355 Farm Economic Survey by HAVA Extension Office, March 1355.

APPENDIX TABLE 2

Average Farm Family Income, Number of Farm Families, Average Family Size and Per Capital Income at Different Income Levels, 1354

Demand Area	HAVA S.A.	1354 Adjusted Net Income	No. of Farms 1354	Percent of Demand Area	At 1349 Prices NFFI* (1349)	At 1349 Prices Annual Growth NFFI 1354/49	At 1354 Prices NFFI* 1349)	At 1354 Prices NFFI* 1354/49	At 1354 Prices Annual Growth %
B	Seraj	22,400	1,520	32					
	Central Girishk	60,500	2,130	44					
	Nowzab	10,400	1,165	24					
	Average/Total	36,300	4,815	100	23,544	1.54	28,250	1.28	5.0
C	Nadi Ali	46,900	2,000	29					
	Marja	40,600	2,342	34					
	Shamalon	54,600	2,590	37					
	Average/Total	50,000	6,933	100	35,392	1.41	42,470	1.18	3.4

Demand Area	Percent of Families 1349	Percent of Families 1354	Percent of Average NFFI	1354 Average NFFI*	1354 Family Size	1354 Per Capita Income
B	30	34	34	12,300	8.5	1,447
	46	16	58	21,000	8.5	2,477
	46	22	67	24,300	10.6	2,292
	46	10	151	54,800	15.4	3,558
	24	13	215	78,000	12.0	6,500
	24	5	655	237,700	19.0	12,510
C	11	15	29	14,500	5.5	2,635
	76	36	88	44,000	8.1	5,432
	76	31	111	55,500	8.6	6,453
	76	8	146	73,000	10.8	6,760
	13	8	183	91,500	13.8	6,630
	13	2	473	236,500	24.0	9,855

* NFFI = Net Farm Family Income (in Afs)

APPENDIX TABLE 3

Projections of NFFI, Family Size, and Per Capita Income, by Income Groups 1354-1359*

Area	Percent of Farms 1354	Percent of Farms 1359	Percent of Average NFFI	NFFI 1359	No. in Family	Av. Per Capita Income
B-	34	20	40	26,700	9.8	2,725
Seraj	16	30	64	42,700	9.2	4,640
Central	22	34	74	49,400	12.2	4,050
Girishk	10	6	160	106,700	17.8	5,995
Nowzab	13	7	235	156,700	13.8	11,360
	5	3	700	466,900	22.0	21,200
Total and Average	100	100		66,700	11.8	5,650
C-	15	15	27	25,000	6.3	3,970
Nadi Ali						
Marja	36	36	83	76,900	9.4	8,180
Shamalon	31	31	105	97,200	9.9	9,820
	8	8	137	126,900	12.5	10,200
	8	8	172	159,300	16.0	9,960
	2	2	445	412,100	27.7	14,800
Total and Average	100	100		92,600	10.1	9,170

* At 1354 Price Levels

APPENDIX TABLE 4

Net Farm Family Income (NFFI) Distribution and Average Annual Growth Rates, 1354-1369

DEMAND AREA 'B'

	Percent of Families 1354	1354 NFFI (Afs)	Percent of Families 1359-69	1359 NFFI (Afs)	1364 NFFI (Afs)	1369 NFFI (Afs)	Average Annual Growth Rates in Percent		
							1354-59	1359-64	1364-69
	34	12,300	20	26,700	39,200	50,000			
	16	21,000	30	42,700	62,700	80,000			
	22	24,300	34	49,400	72,600	92,500			
	10	54,800	6	106,700	156,800	200,000			
	13	78,000	7	156,700	230,200	293,800			
	5	237,700	3	466,900	685,700	875,000			
Average				66,700	98,000	125,000	10%	8%	5%

DEMAND AREA 'C'

	Percent of Families 1354-69	1354 NFFI (Afs)	1359 NFFI (Afs)	1364 NFFI (Afs)	1369 NFFI (Afs)	Average Annual Growth Rates in Percent		
						1354-59	1359-64	1364-69
	15	14,500	25,000	33,500	42,700			
	36	44,000	76,900	102,800	131,100			
	31	55,500	97,200	130,100	165,900			
	8	73,000	126,900	169,700	216,500			
	8	91,500	159,300	213,100	271,800			
	2	236,500	412,100	551,400	703,100			
Average			92,600	123,900	158,000	12%	6%	5%

Demand Area 'B': Seraj, Central Girishk and Nowzab
Demand Area 'C': Nadi Ali, Marja and Shamalon

APPENDIX TABLE 5

Comparison of Net Farm Family Income (NFFI) and Non-Electric Energy Costs (AFS)
And Percent of Families Using and Purchasing Supplies

Area	1354 Annual NFFI	Annual Non-Electric Energy Cost			Energy Cost as Percent of Annual NFFI		
		Total	Wood	Kerosene	Total	Wood	Kerosene
C-							
Nadi Ali	46,900	2,400	1,636	764	5.1	3.5	1.6
Marja	47,600	2,150	1,464	688	4.5	3.1	1.4
Shamalon	54,600	684	71	613	1.3	0.1	1.1
Average	50,000	1,680	998	682	3.4	2.0	1.4
B-							
Seraj	22,400	744	109	635	3.3	0.5	2.8
C. Girishk	60,600	1,920	1,133	787	3.2	1.9	1.3
Nowzad	10,400	1,896	1,326	570	18.2	12.8	5.4
Average	36,300	1,538	852	686	4.2	2.3	1.9

	Wood		Kerosene	
	Using*	Purchasing*	Using*	Purchasing*
C-				
Nadi Ali	82	47	76	76
Marja	94	6	100	100
Shamalon	100	3	100	100
B-				
Serja	100	8	100	100
C. Girishk	100	32	100	100
Nowzad	100	50	100	100

* Percent of the total number of families surveyed.

APPENDIX TABLE 6

Maximum Amounts Potential Consumers Can Pay for the Connection Cost and Electricity, Areas B & C, 1354

Area	Connection Cost	Electricity Costs Monthly (Afs)	Electricity Costs Annual (Afs)	Annual Income	Electrical Cost Percent of Income
B					
Seraj	4,140	109	1,308	22,400	5.8
C. Girishk	3,700	130	1,560	60,600	2.6
Nowzad	1,325	67	804	10,400	7.7
Average	3,270	108	1,296	36,300	3.6
C					
Nadi Ali	1,800	120	1,440	46,900	3.1
Marja	1,850	141	1,692	47,600	3.6
Shamalon	6,370	174	2,088	54,600	3.8
Average	3,508	147	1,765	50,000	3.5

APPENDIX TABLE 7

APPENDIX TABLE 8

Distribution of Total Consumer Expenditures by Major Category

County or City	Reference Period	Distribution of Consumption Expenditures (In Percent) Food & Drink	Rent, etc.	Fuel & Light	Clothes	Misc.
Lashkar Gah-Urban	1968	60.7	5.3	9.6	8.6	15.8
-Rural	1968	65.6	1.2	7.3	7.6	18.3
U.S.A.-Urban	1960/61	26.3	22.0	3.9	9.5	38.3
-Rural	60/61	22.9	17.7	5.9	10.8	42.7
U.K.	1964	33.0	19.2	6.3	9.2	32.3
Ghana-Urban	61/62	53.6	12.3	4.3	12.0	17.8
-Rural	61/62	60.0	4.1	9.1	14.8	12.0
Jamaica-Urban	1958	49.5	21.6	2.6	9.9	16.4
-Rural	1958	69.8	2.0	6.0	10.0	12.1
India-Urban	57/58	62.1	4.9	6.3	7.9	18.8
-Rural	57/58	69.8	2.0	6.0	10.1	12.1
Iran-Urban	1959	48.7	17.8	4.1	10.4	19.0
Pakistan (Karachi) - Urban	55/56	54.1	11.0	6.1	6.2	18.5
- Rural	1961	65.2	8.4	7.1	6.2	13.1
Philippines	1961	57.7	13.0	4.0	7.4	17.9

From 'Lashkar Gah Survey: A Demographic and Econometric Analysis, by M. A. Asiel, Kabul University, 1349, Table 27. Data for areas other than Lashkar Gah are based and computed from U.N. 'Year Book of Labor Statistics, 1966,' Table 28.

Potential Demand Projection For Area B

Year	Percent of Families	Avg. NFFI	Electricity Costs as Percent of Average NFFI: A I	B I	C I	A III	B III	C III
1354	34	12,300	16.1	23.1	37.1	27.8	41.0	71.9
	16	21,000	9.5	13.6	21.9	16.3	24.0	42.1
	22	24,300	8.2	11.7	18.9	14.1	20.7	36.1
	10	54,800	3.6	6.2	8.4	6.2	9.2	16.1
	13	78,000	2.2	3.7	5.9	4.4	6.5	11.3
	5	237,700	0.8	1.2	1.9	1.4	2.1	3.7
Average	100	36,300	4.9	7.0	11.4	8.5	12.5	21.9
1364	20	39,200	5.1	7.3	11.5	8.7	12.9	22.6
	20	62,700	3.2	4.5	7.2	5.5	8.0	14.1
	34	72,600	2.7	3.9	6.2	4.7	6.9	12.2
	6	156,800	1.3	2.9	2.9	2.2	3.2	5.6
	7	230,200	0.9	1.2	2.0	1.5	2.2	2.8
	3	685,700	0.3	0.4	0.7	0.5	0.7	1.3
Average	100	98,000	2.0	2.9	4.6	3.5	5.1	9.0

Year	Percent of Families	Avg. NFFI	Electricity Costs as Percent of Average NFFI: A I	B I	C I	A III	B III	C III
1359	20	26,700	7.4	10.7	16.9	12.8	18.9	33.1
	30	42,700	4.6	6.7	10.6	8.0	11.8	20.7
	34	49,400	4.0	5.8	9.1	6.9	10.2	17.9
	6	106,700	1.9	2.7	4.2	3.2	4.6	8.2
	7	156,700	1.3	1.8	2.9	2.2	3.2	5.6
	3	466,900	0.4	0.6	1.0	0.7	1.0	1.9
Average	100	66,700	3.0	4.3	6.8	5.1	7.6	13.3
1369	20	50,000	4.0	5.7	9.0	6.8	10.1	17.1
	30	80,000	2.5	3.6	5.6	4.3	6.3	11.1
	34	93,500	2.1	3.1	4.9	3.7	5.4	9.6
	6	200,000	0.9	1.4	2.3	1.7	2.5	4.4
	7	293,800	0.7	1.0	1.5	1.1	1.7	3.0
	3	875,000	0.2	0.3	0.5	0.4	0.6	1.0
Average		125,000	1.6	2.3	3.6	2.7	4.0	7.1

	A_I	B_I	C_I	A_{III}	B_{III}	C_{III}
Assumed Annual Kwh Usage	700	1,100	2,200	700	1,100	2,200
Afs/Kwh	1	1	1	3	3	3
Total Annual Cost of Electricity	1,986	2,847	4,598	3,420	5,041	8,844

APPENDIX TABLE 9

Potential Demand Projection For Area C

Year	Percent of Families	Avg. NFFI	Electricity Costs as Percent of Average NFFI: A I	B I	C I	A III	B III	C III
1354	15	14,500	13.7	19.6	31.1	23.5	34.8	61.0
	36	44,000	4.5	6.5	10.2	7.8	11.5	20.1
	31	55,500	3.6	5.1	8.1	6.1	9.1	15.9
	8	73,000	2.7	3.9	6.2	4.7	6.9	12.1
	8	91,500	2.2	3.1	4.9	3.7	5.5	9.7
	2	236,500	0.8	1.2	1.9	1.4	2.1	3.7
Average		50,000	3.7	5.4	8.5	6.4	9.5	16.1
1364	15	33,500	5.9	8.5	13.5	10.2	15.0	26.4
	36	102,800	1.9	2.8	4.4	3.3	4.9	8.6
	31	130,100	1.5	2.2	3.5	2.6	3.9	6.8
	8	169,700	1.2	1.7	2.7	2.0	3.0	5.2
	8	213,100	0.9	1.3	2.1	1.6	2.4	4.2
	2	551,400	0.4	0.5	0.8	0.6	0.9	1.6
Average		123,900	1.6	2.3	3.6	2.8	4.1	7.1

Year	Percent of Families	Avg. NFFI	Electricity Costs as Percent of Average NFFI: A I	B I	C I	A III	B III	C III
1359		25,000	7.9	11.4	18.0	13.7	20.2	35.4
		76,000	2.6	3.7	5.9	4.4	6.6	11.5
		97,200	2.0	2.9	4.6	3.5	5.2	9.1
		126,900	1.6	2.2	3.6	2.7	4.0	7.0
		159,300	1.2	1.8	2.8	2.1	3.2	5.6
		412,100	0.5	0.7	1.1	0.8	1.2	2.1
Average		92,600	2.1	3.1	4.9	3.7	5.4	9.6
1369		42,700	4.7	6.7	10.6	8.0		
		113,100	1.5	2.2	3.4	2.6	3.8	6.7
		165,900	1.2	1.7	2.7	2.1	3.0	5.3
		216,500	0.9	1.3	2.1	1.6	2.3	4.1
		271,800	0.7	1.0	1.7	1.3	1.9	3.3
		703,100	0.3	0.4	0.6	0.5	0.7	1.3
Average		158,000	1.3	1.8	2.8	2.2	3.2	5.6

Note: Annual consumption and cost same as shown in footnote of Table 9.

APPENDIX TABLE 10

Number of Farm Families, Percent Electrified and Average Family Consumption

Kajakai Service Area*

	Number of Farm Families by Area						Percent of Families Electrified and Average Demand Per Family Per Year			
			Helamand Valley				Kwh @ 1 Afs/Kwh		Kwh @ 3 Afs/Kwh	
	A	B	C	D	Total	Arghandab Valley	% Families	kwh/Fam.	% Families	Kwh/Fam.
1349	5,235	4,235	6,479	2,322	18,387	6,111				
1354	5,811	4,811	6,931	3,686	21,344	6,200				
1359	6,200	7,500	8,300	4,200	26,200	6,200	64	697	26	710
1364	6,500	7,400	8,300	5,000	27,300	6,200	83	990	34	977
1369	6,500	7,500	8,300	5,000	27,300	6,200	92	1,248	68	1,045

* Based on rates of growth projected for Helmand Valley Areas B and C. Potential demand for 1354 derived in the analysis summarized in Table 9 is deducted from all future demand estimates as actual 1354 utilization was negligible.

NOTE:

Number of farms in Helmand Valley in 1364 estimated to increase by 6,000 over the 1354 total. This is based on 26,000 Ha of additional irrigated land, or 130,000 jeribs at 20 jeribs average per farm for the new settlers.

Area Definition

A = Sanguin, Mosa Qala, Kajakai

B = Seraj, Central Girishk, Nowzad

C = Nadi Ali, Marja, Shamalon

D = Darweshan, Khanashin

Arghandab Valley = Maiwand, Dand-Daman, Arghandab, and Panjuai.

APPENDIX TABLE 11

Projected Total MWH Demand of Farm Households in the Helmand and Arghandab Valleys, 1359-1369, with Kwh Cost at 1 and 3 Afs

Year/Price	Helmand Valley Area A @1	A @3	B @1	B @3	C @1	C @3	D @1	D @3	Arghandab Valley @1	Arghandab Valley @3	Total @1	Total @3
1359	2,765	1,145	2,380	521	4,628	2,544	1,874	775	2,766	1,145	14,413	6,030
1364	5,341	1,938	5,470	1,180	17,459	3,573	4,109	1,491	5,095	1,849	27,474	10,031
1369	7,463	4,628	7,320	2,965	10,754	8,322	5,322	3,560	7,119	4,414	38,488	23,889

Area Definition:

Helmand Valley

A = Sanguin, Mosa Qala, Kajakai
B = Seraj, Central Girishk, Nowzad
C = Nadi Ali, Marja, Shamalon
D = Darweshan, Khanashin

Arghandab Valley

Maiwand
Dund-Daman
Arghandab
and Panjwai

APPENDIX TABLE 12

Total Annual Family Income of Electrified and Non-Electrified
Town Families by Income Group - Upper Helmand Valley, Kandahar and Jalalabad, 1354

Total Family Income Group (000 Afs)	Upper Helmand: Percent of Families: Electrified	Upper Helmand: Percent of Families: Non-Electrified	Upper Helmand: Cumulative Percent of Families: Electrified	Upper Helmand: Cumulative Percent of Families: Non-Electrified	Kandahar: Percent of Families: Electrified	Kandahar: Percent of Families: Non-Electrified	Kandahar: Cumulative Percent of Families: Electrified	Kandahar: Cumulative Percent of Families: Non-Electrified	Jalalabad: Electrified Only	Jalalabad: Cumulative %
1 (0 - 20)	10	10	10	10	17.5	25.0	17.5	25.0	8.6	8.6
2 (21 - 40)	52	42	62	52	35.0	42.5	42.5	67.5	28.5	37.1
3 (41 - 60)	21	17	83	69	20.0	15.0	72.5	82.5	37.2	74.3
4 (61 - 80)	11	11	94	80	17.5	10.0	90.0	92.5	11.4	85.7
5 (81 -100)	2	10	96	90	0.0	7.5	90.0	100.0	11.4	97.1
6 (101 -120)	2	6	98	96	2.5	0.0	92.5	100.0	2.9	100.0
7 (121 -140)	-	-	98	96	0.0	0.0	92.5	100.0	-	100.0
8 (141 -160)	2	-	100	96	2.5	0.0	95.0	100.0	-	100.0
9 (161 -180)	-	2	100	98	2.5	0.0	97.5	100.0	-	100.0
10 (180+)	-	2	100	100	2.5	0.0	100.0	100.0	-	100.0
Total	100	100	100	100	100.0	100.0	100.0	100.0	100.0	100.0
Average Family Income (000 Afs)	43.4	52.9			48.6	39.0			51.1	
No. of each sample	60	60			60	40			40	

APPENDIX TABLE 13

Population and Number of Households
Kajakai Service Area Urban Centers, 1352-1369
Based on Family Size of 8**

Area	Population*					Number of Households				
	1352	1354	1359	1364	1369	1352	1354	1359	1364	1369
Helmand										
Lashkar Gah	15,000	16,400	20,000	24,300	29,600	1,875	2,050	2,500	3,038	3,700
Other Urban	14,000	16,000	19,500	23,700	28,800	1,750	2,000	2,438	2,962	3,600
Subtotal	29,000	32,400	39,500	48,000	58,400	3,625	4,050	4,938	6,000	7,300
Arghandab										
Kandahar	160,000	174,900	197,890	223,900	253,300	20,000	21,000	21,738	27,990	31,662
Total Urban	189,000	207,000	237,400	271,900	311,700	23,625	25,910	29,767	33,990	38,962

* 1352 and 1354 Population estimated from various sources: 1354-1369 projections assume a 4.0 percent annual rate of increase for Helmand Valley Urban Areas and a 2.5 annual rate of increase for the Kandahar Area.

** Family size based on estimates obtained from several reports. Town energy survey indicates average family of 9 to 10 persons. For total household projections the lower figure is used.

APPENDIX TABLE 14

Projection of Total Town Population, ercent Electrified,
Per Capita Income and Electrical Energy Demand
Upper Helmand Valley, 1354-1369

	1352	1354	1359	1364	1369
Total Urban Population	29,000	32,400	39,500	48,000	58,400
Percent Electrified (%)	34.7	40.0	48.0	54.4	60.0
Number Electrified	10,100	13,000	19,000	26,000	35,000
Average Annual Per Capita Income (Afs)					
Electrified		4,846*			
All Families		5,146*	5,680	6,270	6,925
Average Annual Per Capita Kwh					
Actual From sample		160*			
Trend Value*		160	187	207	228
Total Demand MWH/year					
Actual From Sample		2,100			
Trend Value*		2,100*	3,600	5,400	8,000

* Based on relationship of per capita Kwh usage equal to 0.033 times per capita income. This coefficient is derived from Jalalabad survey data. See Exhibit VI.

APPENDIX TABLE 15

Projection of Total Town Population, Percent Electrified
Per Capita Income and Electrical Energy Demand
Kandahar, 1354-1369

	1352	1354	1359	1364	1369
Total Urban Population	160,000	174,900	197,900	223,900	253,300
Percent Electrified (%)		30	45	58	66
Number Electrified		53,000	89,000	130,000	167,000
Average Annual Per Capital Income					
Electrified		4,543*			
All Families		4,960*	5,475	6,045	6,675
Average Annual Per Capita Kwh					
Actual From Sample		81*			
Trend Values*		150	180	200	220
Total Demand MWH/Year					
Actual From Sample		4,300			
Trend Value*		7,950	16,000	26,000	36,700

* Based on relationship of Per Capita Kwh usage equal to 0.033 times per capita income. This coefficient is derived from Jalalabad survey data. See Exhibit VI.

APPENDIX TABLE 16

Average Annual Family Income and Energy Costs for Non-Electrified Households
Lashkar Gah, Girishk, Kandahar and Abbaza Ha, 1354 (In Afs)

	Lashkar Gah	Girishk	Kandahar	Abbaza Ha
A. Average Annual Family Income	46,600	59,086	38,978	47,490
B. Average Annual Energy Cost:				
Wood	4,025	4,275	N.A.	Own Source
Kerosene	1,989	1,379		1,187
Battery	62	269		263
Total	6,077	5,923		1,450
Energy Cost/Family Income (%)	13.0	10.0		3.1
C. Maximum Amount Potential Customers Willing to Pay for:				
1. Connection Cost	2,290	2,305	1,733	1,185
Percent of (A)	4.9	3.9	4.4	2.5
2. Electricity cost/month	320	155	283	148
Electricity cost/year	3,840	1,860	3,396	1,776
Percent of (A)	8.2	3.1	8.7	3.7
Sample Size	20	20	40	20

APPENDIX TABLE 17

Average Annual Family Income and Energy Costs for Electrified Households in Kajakai Service Area (1354)

	Lashkar Gah	Girhshk	Kandahar	Marja	Jalalabad
A. Average Annual Family Income (Afs)	43,958	42,790	48,561	41,322	51,100
B. Average Annual Energy Costs:					
1. Non-Electrical					
Wood	3,968	3,477	3,943	2,675	6,000
Kerosene	-	26	-	-	-
Battery	-	36	-	-	-
Total	3,968	3,539	3,943	2,675	6,000
Total % of Family Income	9.0	8.3	8.1	6.5	11.7
2. Electrical-Kwh Cost/year	1,531	1,335	2,439	997	1,181
as percent of Income	3.5	3.1	5.1	2.4	2.3
3. Total Energy Cost	5,499	4,874	6,382	3,672	7,181
as percent of Income	12.5	11.4	13.1	8.9	14.1
4. Avg. Elect. Appliance Cost	838	1,682	1,414	3,597	3,268
5. Annual Appliance Cost	168	336	283	719	654
6. Total Annual Energy & Appliance Cost	5,667	5,210	6,665	4,391	7,835
As percent of Income	12.9	12.2	13.7	10.6	15.3
7. Connection Cost (excluding wiring)	1,780	1,465	1,500	0*	5,200**
As percent of Income	4.0	3.4	3.1		10.2
8. Annual Connection Cost (4-yr. basis)	446	336	376	0*	1,302
9. Total Ann. Energy, Appliance & Connection Cost	6,113	5,546	7,041	4,391	9,137
As percent of Income	13.9	13.0	14.5	10.6	17.9
Sample Size	20	20	40	18	40

* Paid for by HACU

** Includes wiring costs

APPENDIX TABLE 18

Summary of Energy Survey of
Town and Farm Family Income, Energy Use and Costs

		Town Families			Farm Families	
		Electrified	Non-Electrified		Non-Electrified	
		Note 1	Note 2	Note 1	Area C	Area B
I.	Average Annual Family Income (Afs)	45,968	52,843	45,910	50,000	36,300
II.	Annual Energy Costs (Afs)					
	Wood	3,833	4,150		998	852
	Kerosene	15	1,684		682	686
	Other		104		-	-
	Total Non-Electrical	3,848	6,000		1,680	1,538
	% of Family Income	8.4	11.4		3.4	4.2
	Electrical (kwh) Cost	1,936	0		0	0
	% of Family Income	4.2	0		0	0
	Total Energy Cost	5,784	6,000		1,680	1,538
	% of Family Income	12.6	11.6		3.4	4.2
III.	Willingness to Pay					
	Connection Cost (Afs)			2,000	3,508	3,270
	% of Family Income			4.4	7.0	9.0
	Annual Electricity (kwh) Cost (Afs)			3,120	1,765	1,296
	% of Family Income			6.8	3.5	3.6
IV.	Actual Connection Cost (Afs)	1,550				
	% of Family Income	3.4				
V.	Sample Size	80	40	80	62	59

Note 1 : Includes Lashkar Gah, Girishk and Kandahar

Note 2 : Includes Lashkar Gah and Girishk

APPENDIX TABLE 19

APPENDIX TABLE 20

Typical Appliance Costs in Afghanistan (Afs)

Electrical Stove,	15,000 to 28,000
Refrigerator	16,000 to 27,000
Washing Machine	10,000 to 16,000
Iron-Steam	1,500
Iron-Regular	850
Vacuum Cleaner	7,800
Toaster	1,450
Mixer	1,500
Fan	2,000
Space Heater - 1,000W	750
Space Heater - 2,000W	2,000
Immersion Heater	120

Source: Retail store survey Kabul, May 1355.

APPENDIX TABLE 21

Number of Farms in HAVA Service Areas
Helmand Valley 1349 and 1354

HAVA Service Areas	Number of Farms		
	1349	1354	1354-1349
Nadi Ali	1,947	1,999	52
Marja	1,169	2,343	1,174
Shamalon	3,363	2,589	- 774
Darweshan	1,525	2,821	1,296
Khanishin	797	865	68
Seraj	1,540	1,517	- 23
Central Girishk	1,725	2,129	403
Sanguin	3,228	3,551	323
Kajakai	3,228	3,551	323
Mosa Quala	2,123	2,365	242
Nowzad	969	1,165	196
Total	18,387	21,344	2,957

Source: 1349 from FES 1349, 1354 from HAVA Department of Statistics, March, 1355.

BOGHRA BRESHNA

Monthly Peak Demand and Energy Sendout.
of the
Girishk Hydro Plant

MONTH	1344 KW	1344 MWH	1345 KW	1345 MWH	1346 KW	1346 MWH	1347 KW	1347 MWH	1348 KW	1348 MWH	1349 KW	1349 MWH	1350 KW	1350 MWH	1351 KW	1351 MWH	1352 KW	1352 MWH	1353 KW	1353 MWH	1354 KW	1354 MWH
Hamal			925		1400	580	1225	606	1100	468	1275	562	1300	527	1475	604	1850	689	1725	629	1700	772
Saur	825		800		900	446	1100	493	1025	377	1175	536	1400	522	1150	512	1625	570	1425	535	1725	663
Jouza	800		725		900	420	1050	510	900	430	1025	411	1350	530	1100	458	1325	542	1400	527	1600	612
Saratan	775		700		925	408	950	447	1025	480	1350	470	1450	602	1075	476	1350	523	1200	498	1525	558
Asad	800		700		850	407	940	413	950	423	1400	646	1425	613	1200	484	1400	531	1250	475	1450	583
Sanbula	850		800		975	403	950	434	1050	400	1450	669	1375	516	1075	474	1525	540	1500	530	1675	654
Mizan	900		875		1250	425	1075	434	1150	414	1525	554	1800	642	1600	527	1475	562	1775	631	2100	641
Akrab	1275		1600		1500	611	1375	507	1750	514	1900	725	1850	813	2050	720	2200	698	2125	715	2300	949
Kous	1300		1650		1900	919	2000	737	1975	888	2300	947	2100	909	2200	1051	2250	1086	2225	1025	2275	1111
Jady	1450		1875		2100	1067	1950	983	2050	1033	2250	1094	2275	1166	2275	1336	2275	1239	2250	1139	2250	1259
Dalwa	1475		1800		2050	1127	1825	946	2100	1144	2150	1085	2250	1220	2200	1218	2250	1341	2250	1197	2250	1217
Hoot	1275		1475		1475	764	1250	598	2000	850	2025	780	2200	1089	2200	875	2150	948	2250	935	2200	1214
Total		5450		5940		7577		7108		7421		8479		9149		8735		9269		8836		10233
L.F.		42.2		36.2		41.2		40.6		40.3		42.1		45.9		43.8		46.5		44.8		50.8

APPENDIX TABLE 22

BOGHRA BRESHNA

ELECTRIC ENERGY CONSUMPTION

BY

CLASSIFICATION

	System			Residential			Bazaar			Commercial			
Year	MWH Output of Girishk Hydro Station	MWH Used by Cotton Plant	MWH Available For Non-Industrial Loads	Number of Customers	Total MWH Used	Average KWH Per Customer	Number of Customers	Total MWH Used	Average KWH Per Customer	Number of Customers	Total MWH Used	Average KWH Per Customer	Non-Metered Loads Plus Losses
			(1÷2)			(5÷4)			(8÷7)			(11÷10)	MWH (3-5-8-11)
	1	2	3	4	5	6	7	8	9	10	11	12	13
1347	7108	93	7015	541	1763	3260	105	84	800	13	162	12600	5006
1348	7421	367	7054	609	2310	3790	191	182	950	28	1911	68300	2651
1349	8479	861	7618	708	2400	3390	198	257	1300	32	1650	51600	3311
1350	9149	889	8260	995	2840	2850	208	259	1250	39	1760	45100	3401
1351	8735	288	8447	1076	3046	2830	249	282	1130	48	2122	44200	2997
1352	9269	236	9033	1258	3614	2870	270	347	1290	51	2063	40500	3009
1353	8836	427	8409	1326	3604	2720	281	352	1250	55	1863	33900	2590
1354	10233	890	9343	1444	3683	2550	319	497	1560	65	2499	38400	2664

DATA PROVIDED BY THE BOGHRA BRESHNA

APPENDIX TABLE 23

NANGARHAR BRESHNA

Monthly Peak Demand and Energy Sendout

MONTH	1344		1345		1346		1347		1348		1349		1350		1351		1352		1353		1354	
	KW	MWH	KW	MWH	KW	MWH	KW	MWH	KW	MWH	KW	MWH	KW	MWH	KW	MWH	KW	MWH	KW	MWH	KW	MWH
Hamal			870		1400		1700		2470		2400		2670		6200	2650	6000	2180	5840	2320	5500	2660
Saur			920		1100		1450		1820		2400		2210		5400	2240	5500	2500	6000	2680	5500	2980
Jouza			800		1150		1830		2320		2460		2450		5200	3020	5240	2640	5760	3220	5720	2820
Saratan			930		1620		1980		2690		2590		2550		4720	2970	5080	2910	5480	3150	5760	3200
Asad			850		1670		2100		2550		2500		2550		4920	2530	5160	2590	5240	2880	5560	3000
Sanbula			1040		1870		2400		2770		2550		1870		5160	2800	5400	2770	5520	3100	6160	2950
Mizan			1180		1700		1870		2200		2260		1930		4640	2260	5400	2670	5760	2700	5920	2870
Akrab			1730		1560		1950		2220		2360		1930		5400	2640	5920	2480	6250	2920	7600	3050
Kous			2460		1850		2000		2600		3100		3010		6200	2850	6880	3250	7200	3400	8160	3520
Jady		1120	2800		1570		2540		3120		3300		6700	3660	7560	3860	7800	3800	8120	3880	8920	4430
Dalwa		1540	2400		2530		2620		2900		3020		6900	3450	7440	3850	7600	3880	8920	4000	8200	4200
Hoot		1100	2080		1800		1960		2800		2900		7120	3450	6560	3220	7180	3740	8600	3810	8400	3830
TOTAL			18060		19820		23900		30460		31840		31730		34890		35410		38060		39510	
L.F.													50.9		52.7		51.8		48.7		50.6	

DATA PROVIDED BY THE NANGARHAR BRESHNA

APPENDIX TABLE 24

NANGARHAR BRESHNA

ELECTRIC ENERGY CONSUMPTION

BY

CLASSIFICATION

	Residential			Bazaar			Commercial		
Year	Number of Customers	Total MWH	Average KWH Per Customer	Number of Customers	Total MWH	Average KWH Per Customer	Number of Customers	Total MWH	Average KWH Per Customer
	1	2	(2÷1) 3	4	5	(5÷4) 6	7	8	(8÷7) 9
1346	1512	3160	2050	155	190	1223	-	-	-
1347	1774	3400	1920	198	220	1110	1	0.53	530
1348	1900	3914	2060	202	250	1240	2	50	25000
1349	1925	4817	2500	328	300	915	3	150	50000
1350	2115	5349	2530	428	320	750	3	200	67000
1351	2353	5767	2450	490	350	720	3	250	83000
1352	2484	7225	2910	515	450	870	3	300	100000
1353	2632	6207	2360	540	600	1100	3	400	133000
1354	3067	9020	2940	643	1000	1560	5	600	120000

DATA PROVIDED BY THE NANGARHAR BRESHNA

APPENDIX TABLE 25