IDRC-MR138e

International Development Research Centre

MANUSCRIPT REPORT

A Regional Energy System, Entre Ríos Province, Argentina

Final Report of the Study

September 1986

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IDRC-MR138e

A REGIONAL ENERGY SYSTEM, ENTRE RIOS PROVINCE, ARGENTINA: FINAL REPORT OF THE STUDY

This research has been done with grant CF 3-P 81-0042

Although this manuscript has been edited by Ms. Bernice Perry, it has not been subjected to peer review or rigorous editing by IDRC Communications Division staff. Mention of proprietary names does not constitute endorsement of the product and is given for information only.

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INTRODUCTION

Two previous reports have been produced as a result of this research, the first of which consists of three volumes while the second report is a single volume.

The first gives a complete description of the area to be studied from the bio-geographical, demographic, socio-economic and energy viewpoints, as a reference framework for the research. This includes a detailed description based on polls carried out *in situ* of energy consumption characteristics in the following sectors:

- Urban Domestic, Rural Domestic (Volume I)
- Commercial and Services, Industrial (Volume II)
- Rural Production (Volume III)

This work presents a short, socio-economic characterization of each sector; a description of the number of polls carried out and selection method; and outlines the characteristics of users, installations, and production activity. Subsequently analysis is made of (a) market penetration of the different energy sources and uses, (b) characteristics of the supply of each energy source, (c) consumption characteristics for each specific use (lighting, cooking, water heating, space heating, refrigeration and ventilation, food conservation, other appliances, individual means of transport, water pumping, process heat, power (stationary and mobile), and other production inputs.

In each sector the above information is determined by zones (city size), income level, type of products or size of establishments, as applicable.

Each use gives the quantity and type of appliances used, their degree of penetration in the market, their utilization rates, specific consumptions, number of appliances per user, typical sizes, and energy sources used.

For the urban and rural domestic sector, user preferences are given as regards natural gas and/or electricity in different specific uses (cooking, water heating, space heating, urban transport) and a detailed analysis using income level is made of the penetration of all the appliances

identified. By way of synthesis the urban and rural domestic consumption structure is given by sources and by uses for three income levels, in net or final energy and in useful energy. These values arise from the Integrated Energy Balance of the Province for 1978 previously carried out[1] on the basis of the polls analyzed in this research.

In the commercial and services sector the analysis refers to the following activities: retail and wholesale trade, workshops, dry-cleaners, hospitals, schools, hotels, restaurants, bars and cafeterias.

In the industrial and mining sector all the activities according to the Uniform International Industrial Classification (UIIC) code which are grouped into five-digit levels, are considered.

In the rural production sector ten different activities including agriculture, cattle-raising and forestry are taken into account. In this case all the production inputs are detailed and not only specifically energy ones but kinds of equipment available and their particular characteristics and the structures, absolute values and energy consumption yields of each activity by source and by use in net and useful energy.

The second report aims at the analysis of the different relations existing between the energy variables themselves and the socio-economic variables in each of the sectors mentioned.

In particular, in the domestic sector studies were made of:

(a) the relation between net and useful energy consumption, income and family size;
(b) penetration of uses and appliances in relation to family income;
(c) frequency distribution of net and useful energy consumption per inhabitant, for the urban and rural areas in the three income levels and for the total.

In the rural sector for each of the ten activities selected, the coefficients of production inputs per hectare and per ton were studied, as well as energy consumption by main uses and the total in net and useful energy.

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[1]Province of Entre Ríos Long-Term Global Energy Planning, Final Report Volume 12, CFI, Buenos Aires, 1981.

Moreover, an analysis was made with four different models of the relation existing between total net and useful energy consumption and four main explanatory variables: man-hours worked; HP-hours of machinery used; area of the exploitation; and production obtained (in tons). In each case the corresponding elasticities and the statistical adjustment coefficients were determined.

In the industrial sector activities were re-grouped in order to obtain greater homogeneity and a suitable amount of data for correlating. In this way twelve groups were obtained, for each of which the relation between total energy consumption, consumption of fuels and of electricity, and the production level was analyzed. The man-hours worked/production level ratio was also analyzed.

In addition, for each of the above twelve groups the frequencies distribution of total net and useful energy per ton was analyzed. These frequency distributions were analyzed on the basis of measurements of position, dispersion, asymmetry and kurtosis, suitable to the amount of data available.

In the commercial and services sector, for each of the activities already indicated, an analysis was made of the relation of total energy consumption, electricity consumption and fuels consumption with four explanatory variables: covered surface, personnel employed, sales and persons attended. In all cases, net and useful energy were used, the respective statistical coefficients being indicated.

The second aspect considered was the distribution of frequencies of the specific consumptions in net and useful energy. In this sector specific consumptions were calculated by personnel employed, covered surface, and annual sales. As characteristic parameters of each distribution, those of position, dispersion, asymmetry and kurtosis were given.

General Conclusions

In analytical, statistical-type research based on primary data, it is difficult to draw conclusions of a general nature since the work's greatest interest is to be found precisely in the mass of information available and in the detailed results obtained. In particular, this value is increased by the fact that very little work of this kind exists in the developing countries.

On analyzing the entire experience from the beginning to the end of this research,[2] mention can be made of the following general type conclusions as regards design, execution and processing of the poll:

(a) It is both feasible and advisable to carry out a complete, analytical characterization of a regional energy system on the basis of a relatively small number of polls, whose economic cost in time and in human resources is reasonable, taking into account the amount of investment and operating expenses of the energy system being studied.

(b) In order to come as close as possible to the real situation with a relatively small number of polls, a proper stratification of the system must be made, bearing in mind the main socio-economic and environmental variables which affect energy consumption.

This implies that in addition to the classical division by economic sectors, it is necessary to define within each of them the successive strata that would allow the polling of a group of users that would constitute as homogeneous a consumption module as possible. In this sense, and on the basis of the experience acquired, it can be stated that:

- The domestic or residential sector should be dealt with independently of the services sector. Within the former, it is fundamental to distinguish between the urban and rural area, and within each of them to classify the users in a minimum of three income levels. Second in importance is the stratification of the urban area by city size, in those cases where none of them could qualify as a large metropolis. Division by climatic zones does not appear very necessary for an area of this size, always provided there are no marked contrasts. This does not mean that the climatic features of the area under study should not be considered.

- The industrial and mining sector requires that the large industrial installations, normally not many in the developing countries, be individualized and polled. The remainder can be dealt with by sampling, following stratification or grouping by

[2]The research covers: presentation of the problem, design of the questionnaire, sampling selection, carrying out the pilot poll, survey of the poll, its basic processing and integral exploitation. The present research refers exclusively to the last point.

activities which are homogeneous from the energy viewpoint. The Uniform International Industrial Classification (UIIC) of activities should be observed as closely as possible since census and economic data are normally in accordance with this code. When there are very varied technologies for the same product of group of activities, each one should be polled separately.

- The rural production sector should be stratified, distinguishing between the different types of activities existing in the zone and also taking into account the existence of very different technologies. In this case as well, the objective is to obtain the most homogeneous groups of users possible from the viewpoint of the production function structure and type. When choosing on the spot the users to be polled, particular care must be taken not to distort the sample in function of accessibility of the place.

- In the services sector there is normally a wide diversity of activities with very different energy consumption features. This means first identifying the most important activities in the area to be studied and making the proper stratification in each of them.

- In this particular case a specific poll for the transport sector was not made since sufficiently desegregated secondary data already existed. This is generally quite common. Nevertheless, questions connected with individual and collective transport were included in the domestic sector poll and in the transportation of inputs and products in the production sectors. In areas where traditional or informal transport has greater importance, it becomes necessary to carry out the specific polls.

(c) As regards the polling forms, the intention is that they should permit the maximum amount of information to be obtained on the structure and functioning of the "energy system" of each user to be polled. They should be so drawn up as to permit cross checking the consistency of the information supplied. They should call for data not only on consumption but also on equipment being utilized, classified according to the main uses of each sector. Simultaneously with the energy data "internal" to the system, "external" data (Provisioning) should be required as well as those of a socio-economic nature which would explain the energy consumption.

In the event the energy prices are not easily obtainable from secondary sources or their value depends on localization of the user, it will be advisable to include them in the poll.

In order to draw up a suitable form, it is considered advisable and necessary to undertake one or more pilot polls with the direct participation of the researchers, thus allowing the respective improvements to be made to the form. Although reference to forms used in previous polls is to be recommended, it is necessary to insist on an appropriate design which is fundamentally based on the real situation to be studied.

(d) In the survey stage of the poll it is necessary to give some prior diffusion through suitable communications media in order to obtain maximum collaboration from the users. The pollsters should be experienced in this type of survey and should have direct access to and be familiar with the users to be polled and with the technical characteristics of the activities. They can be suitably trained in specific energy aspects by the researchers directing the study, who would bring to their attention not only the technical problems of energy but also the fundamental social aspects in terms of the specific objective of the task to be undertaken.

It is essential to set up a suitable mechanism for controlling the pollsters in the field and during the survey in order to detect any possible systematic errors of interpretation or other types of problem.

(e) For processing the polls, it is considered fundamental that in the first stage it should be the researchers themselves who make a detailed analysis of each one in order to detect inconsistencies of data and separate the data on sources and uses which each poll contains.

Only when the minimum coherence necessary has been achieved between inputs (purchase or collection of fuels and electricity) and uses (utilization of these sources in all identified activities) is it feasible to proceed to systematic treatment of the polls either manually or, preferably, by computer.

After the systematic treatment of all the polls it will again be necessary to make an analysis of the results obtained for each of the variables included in the poll in each

of the strata or homogeneous modules, in order to evaluate the average values obtained and the resulting dispersion.

In particular, for the modules or strata with few polls (e.g. high income levels in the domestic sector or production activities with few establishments in the area under study), it will be necessary to make a detailed analysis of the results obtained and not use them automatically without first requiring the opinion of the project researchers familiar with the subject.

PART I. SURVEY FINDINGS

The Polls - Overview

On the basis of the polling carried out in the Province of Entre Ríos and on other secondary information, it was possible to prepare an integral energy balance for 1978 for the whole province, discriminating the consumptions by sources for the following sectors: urban domestic, rural domestic, industrial, transport, services and rural production, covering the entire market.

This balance could be made in terms of net or final energy and in terms of useful energy on the basis of estimated yields by sources and by use (and/or appliance) in each consumer sector. For this purpose the consumption structure by sources and uses was employed for each sector for which it was possible to calculate on the basis of information obtained from the poll.

As a consequence, a series of average overall utilization yields was determined (1) by sector, of all the sources and uses; (2) by source, for all the sectors; (3) by use, for all the sectors; and (4) by sources and uses in each sector. This information constitutes a basic indicator for the design of energy conservation policies, for the study of substitutions and for the development and/or adaptation of technologies.

It is important to point out that this analytical estimate achieved a high degree of coherence with the secondary information available as regards sales of all the commercial energy sources for that year.

In addition, using the average yields for each sector, it is possible to make an approximate estimate of the evolution of useful energy consumption in the province for the years 1960 to 1978 which enabled a much more precise understanding of the real evolution of the provincial energy system for a period of almost twenty years and to identify trends which were not evident when analyzing the respective information in net or final energy.

The information obtained from the polls permitted a substantial improvement in the sectoral diagnosis in relation to the energy consumption structure by sectors, by sources and by uses and as

regards the overall utilization yields. Significant data were also obtained as regards the origin and type of energy supplied to the different users in the province.

In other words, for the first time in this country, it was possible to make a complete description and analysis of the operation of a provincial energy system from the resources up to the final utilization of each and every energy source, employing for this purpose in a complementary manner, pre-existing secondary information duly processed, as well as the results of the poll.

This sectoral diagnosis in turn served the purpose of proposing and carrying out various scenarios on the future evolution of the system's energy requirements, using an analytical, detailed methodology.

In addition to the above-mentioned general results, exhaustive processing of the polls allowed a detailed characterization of energy consumption in the sectors mentioned above to be made and a series of specific results or conclusions to be drawn.

Characteristics of the System

The Province of Entre Ríos (PER) is situated in the Argentine Mesopotamia in the River Plate Basin, between latitude 30° and 34°20' south and between longitude 57°48' and 60°20' west. It is completely surrounded by rivers and has an area of 78,781 square kilometers.

Population

In 1980 its population was 908,313 inhabitants, 68.4% of whom lived in urban areas (towns of more than 2,000 inhabitants). The rural population decreased in absolute value (-30%) between 1960 and 1980 and presently 84% lives in dispersed groups (less than 100 inhabitants).

Although in Spanish colonial times the territory was inhabited by Indian nomad tribes, the present population is almost entirely of European origin of which 98.6% is native Argentine; the remaining 1.4% is of foreign origin.

The province has experienced significant emigration since the 1950s and for this reason the population has remained almost stable for twenty years. In the last decade, the process slowed down somewhat and the population grew by 1.13% per annum.

The EAP reached 35.7% of the total population, 26.8% being engaged in the primary sector, 19.8% in the secondary and 43.3% in the tertiary.

The number of men for every 100 women was 98 in 1980 and the structure by ages showed about 32% less for 15 year-olds and about 8.2% for over 65, a tendency towards aging being observed over the last twenty years. This is also seen in the reduction of the number of persons per dwelling, which is only 4.

The number of private dwellings in 1980 was 243,657, 10% of them were unoccupied. Houses represent 80.2%, apartments 2.8%, cottages (ranchos) 8.2%, shacks (vivienda precaria) 7.7% and others 1.1%.

Topography and Climate

From the bio-geographical point of view the province consists for the most part of an undulating plain with the wide delta of the River Paraná at the southern extreme. The brown and black grassland soils provide one of the finest natural resources of the area.

The Province of Entre Ríos has a hot, humid climate with well-defined seasons. The average temperature is about 19°C with an average maximum of 32°C and minimum average of 6-7°C. Humidity is uniformly high in the whole province (68% to 74%). Rainfall is between 1,000 and 1,250 mm per year. The province is not a particularly windy territory but it has a certain level which allows the fairly widespread use of windmills for pumping water.

The hydrographical system is based on four totally internal subbasins, three of them tributaries of the Paraná river (14,000 m^3/seg.) and one of the Uruguay river (4,600 m^3/seg.).

This network has been the chief factor in defining the scenery. Abundant rainfall, mostly impermeable soils and a slight gradient of the land, have generated a vast network of winding water-courses and a parallel dentritic drainage pattern. The ground water aquifers presently being exploited indicate an average depth of 42 meters.

Present vegetation has been strongly influenced by the presence of human beings and it is difficult to distinguish it from the original. There are three main formations: the riverside forests, the brush and the grasslands.

Economic Conditions

From the economic point of view the Province of Entre Ríos is an area of intermediate development with the GGP of 1,100 dollars inhabitant in 1977 (66% of the national average). The primary sector contributes with 18.7%, the secondary with 31.6% and the tertiary with 49.7%. In the last fifteen years a severe drop can be seen in agrarian and industrial sector participation. These activities have been displaced by the growth of the construction, commercial and financial services sector. This evolution of production activities clearly shows the reasons for the migration process out of the province.

Energy System

The energy system of the Province of Entre Ríos can be characterized by a diagram of energy flows from production up to the final use of the energy (Figure No. 1). The main energy resources of the province are renewable, very abundant but barely exploited until now. Consequently, the main energy consumptions are satisfied by non-renewable and scarce primary sources located outside the province. Oil derivatives, produced and processed outside the province, stand out easily as the main source together with electricity and LPG. At useful energy level, electricity represents almost a fourth of the industrial consumption, more than a fourth of the domestic sector and only a sixth of the total. At this level, power and caloric uses are the most important with a percentage close to one half for each, with the remainder for lighting.

At useful energy level the industrial sector is the most important (33.9%), and is basically supplied by fuel oil, electricity and firewood. It is followed by the transport sector (29.3%) which is fueled by gas oil and gasoline; the rural and urban domestic sector (16.8%) has a more diversified provisioning based on LPG, electricity, kerosene and firewood. The rural production sector (14.1%) uses basically gas oil and, to a much lesser degree, electricity, firewood and vegetable wastes. Finally, the services sector (5.3%) basically uses electricity, fuel oil and LPG.

As regards energy sources, the greatest contribution to useful energy consumption, taking all the sectors together, is made by gas oil (29.8%) followed by fuel oil (24.9%), electricity (15.5%), gasoline (11.9%), LPG (7.5%), firewood (4.4%) and kerosene (3.4%). These seven secondary sources contribute 97.4% of the total energy consumed.

With regard to uses, first come process heat (28.3%) and diesel engines (28.0%). They are followed by electricity and electronic uses (12.1%) and Otto engines (12.0%). At a lower level there are cooking (8.3%), water heating (3.2%), space heating (2.9%) and food preservation (2.1%). These eight uses represent a total of 97.0%.

Characteristics of the Polls

The polls were carried out in two stages in 1979 and 1980. There was a total of 811 questionnaires which were distributed as follows:

- urban domestic 210;
- rural domestic 161;
- rural production 102;
- industrial 199; and
- services 139.

The completed questionnaires included, in general, the following type of information for the different sectors: location of the user; main socio-economic characteristics; description of user's activity; energy consumption by sources and by uses; equipment for energy consumptions; opinions with regard to specific sources and/or uses of energy and institutional characteristics of the supplier.

Urban Domestic Sector

The urban population in 1980 (620,988 inhabitants) was distributed among 38 cities, the largest having 159,581 inhabitants. The number of dwellings reached 167,674 giving an average rate of 3.7 inhabitants per urban dwelling in the Province of Entre Ríos.

Of the 38 cities, one had more than 100,000 inhabitants, 2 more than 50,000, 11 more than 10,000 and 24 more than 2,000. Annual average growth of the urban population in the 70's was 2.32%, twice the average provincial growth.

The overall access to education of the total population (rural and urban) can be characterized by stating that 94.5% of children up to 12 years were attending primary school, 41% of 15-year-olds

were attending secondary school, and 9% of 20-year-olds attended university. Problems of lack of education are concentrated in the older groups.

A total of 210 polls were carried out (1.5 per mil users), covering two bio-geographical zones, three city sizes and three income levels. The main conclusions drawn from the treatment of these polls are as follows:[1]

- The results obtained in relation to the population characteristics are significantly similar to the data arising from the National Population Census of 1980. Family size is slightly smaller than that of the rural area and increases in the small cities. It is highest in the medium income levels due to the predominance of retired people in the low level and to modern cultural patterns in the high levels.

- The proportion of persons over 15 years of age is high and increases with income level and city size.

- According to the occupation of the head of the family, the most important group is that of non-active persons, followed by clerks, tradesmen, workers, businessmen and professionals. This structure shows the preponderance of the service sector over the industrial. Workers and retirees are predominant in the low income level, businessmen and professionals in the high and tradesmen in the medium.

  The EAP grows with income level and drops in the small towns. For the whole urban area, the result gave only one person per family working outside the home, while at the high levels of the large towns more than one person works in about 70% of the cases.

  The average income per family increases with income level and is 5.5 times higher in the high level than in the lower ones. Income distribution is better in the south than the north and in the larger towns. Average income per inhabitant is 1,330 dollars (1979). This value is higher in the south zone and in the medium and large towns, while it is considerably lower in the small ones.

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[1]For further details see: A Regional Energy System, the Entre Ríos Province (Argentina), Report No. 1, Volume 1, IDEE, December 1982.

. From an analysis of characteristics of the dwellings, it emerges that the large majority live in single-family houses with an average area of 86.7 square meters with 5.43 rooms (including bathroom and kitchen). In 89.5% of the cases there is running water and almost all of them have suitable sanitary installations. Nearly half are connected to the public sewage system. The size of the towns has a positive effect on: number of apartments and the general conditions of the dwellings, while it is negative as regards the number of precarious dwellings, covered area and running water.

As regards income level, it always has a positive influence but without great differences in the average values.

Figure 1 shows the penetration of the different energy sources in the market. LPG[2] and electricity reach 95% of the market, firewood and kerosene about 50% and charcoal and alcohol about 10%. The average user employs more than three sources at the same time, two of them being LPG and electricity. The remainder are sources for complementary use. Penetration of total LPG, tubes and charcoal increase with city size while electricity, kerosene and alcohol decrease, no tendencies being apparent for bottled gas and firewood.

In the medium and high income LPG and electricity reach saturation. LPG in tubes sharply increases its participation while kerosene, bottled LPG and charcoal decrease their share as income increases. Diversity of sources in use increases with income level and city size.

Figure 2 shows penetration of the different energy uses as it becomes evident from detailed processing of the polls. Cooking, other appliances and lighting have full penetration for all income levels. These are followed by water heating, food preservation, refrigeration and ventilation, space heating and individual transport with penetration between 96.6% and 39.6%. The penetration of space heating is always lower than that of refrigeration and ventilation because of climatic conditions and the automobile reaches only half the penetration of other uses.

In general, the higher the city size the higher the different appliances' penetration, except for the radio. In the main report an analysis of the influence of city size on the penetration of some specific appliances associated with each energy use is included.

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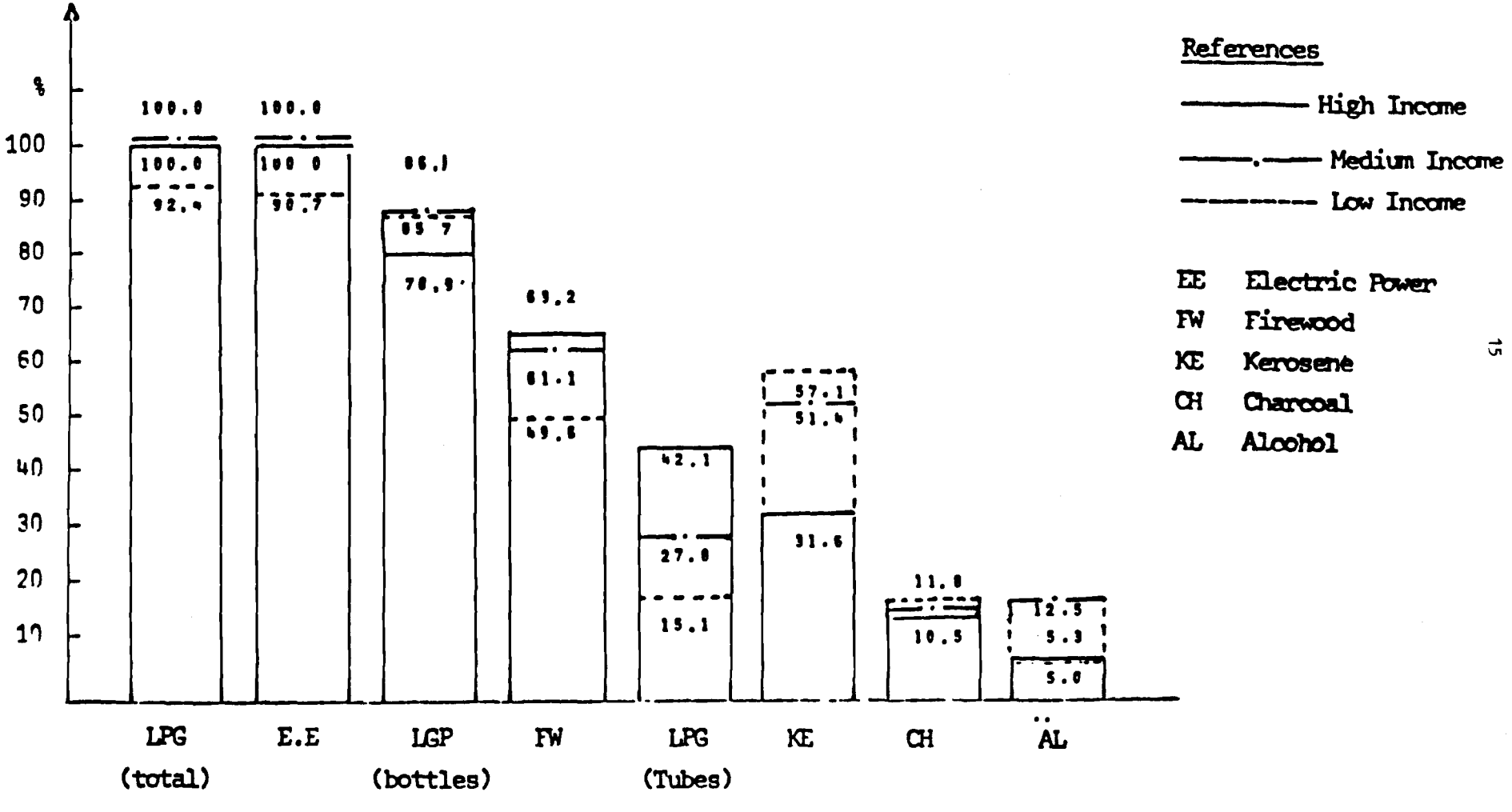
[2]LPG is distributed in bottles (10 kilograms) which do not require special installation and in tubes (45 kilograms) which require a relatively expensive installation. The former covers 85.2% of the market and the latter only 21.9%.

FIGURE 1

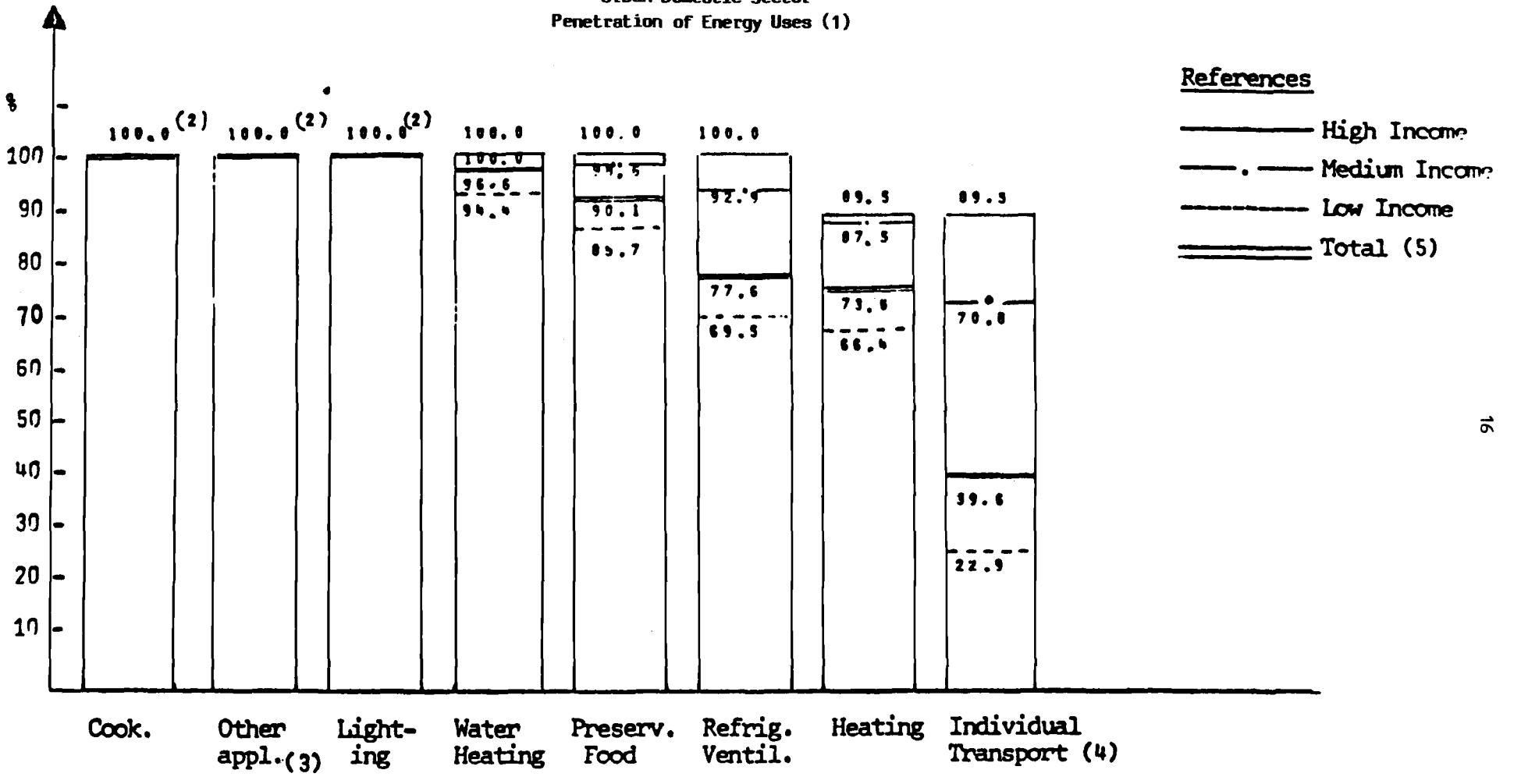
Province of Entre Ríos
Urban Domestic Sector
Penetration of Energy Sources (1)



(1) Defined as percentage of the families using it, not as participation in the market.

FIGURE 2

Province of Entre Ríos
Urban Domestic Sector
Penetration of Energy Uses (1)



(1) Defined as the percentage of the families which utilize it, independently of the source or appliance used.
(2) For these three uses penetration is 100% at all income levels.
(3) Refers to electrical appliances such as: radio, iron, TV, etc. Having at least one of them.
(4) Refers to motorized means (automobile, pick-up or motorbike).
(5) To calculate the total the real distribution of the population by income level was used.

Energy Supply Characteristics

With regard to the energy supply characteristics, the following aspects are noteworthy. Electricity is supplied to the user's dwelling; alcohol and charcoal are purchased in the neighborhood (2 or 3 blocks distance); bottled LPG and kerosene are obtained from stores further away; and LPG in tubes and firewood are obtained from the outskirts of the town or from other towns. In general, provisioning distances decrease as city size increases.

No important problems of fuel supply have been detected, except for kerosene and firewood collected in the lower income levels. However, almost half of the users have expressed dissatisfaction with the electricity supply due to the frequent power cuts. This situation is more serious in the small towns. Power supply is provided by cooperatives in one-third of the cities and in the other two-thirds by the national (State) power company.

As regards firewood, only one-sixth of the users obtain it directly while the rest purchase it. Of the latter, the greater portion is hardwood and is transported in carts, trucks and vans. Of the former, two-thirds is obtained outside the property boundaries and in almost all cases it is the responsibility of the adults. It is important to point out here that in the system being studied firewood is not the main source and in most cases it is only used for preparing a typical Argentine meal, "el asado" or barbecue, especially at weekends. This explains why its penetration and use increase with income level, the opposite of what occurs in other countries or regions.

The main conclusions drawn from the detailed analysis of each use are given below:

Lighting is electric for 94.3% of users, utilizing in all cases incandescent lamps, complemented in one-third of the users by flourescent lamps. On the average there are 10.8 and 1.7 lamps per user of each type (11.4 for both) with an average power of 42.4 W and 31.2 W respectively, which means a total installed power of 477 W/user. A part of this power (15% for incandescent and 4% for flourescent) is normally not in use, the utilization factors being 3.19 hours for flourescent lamps and 1.82 hours for incandescent lamps. Income level produces a systematic variation in the number of appliances, their average power and the utilization factor, as a result of which high income level consumption is three times greater than that of the low income level group.

The use of fuels in a permanent manner only reaches 5.7% of the users, with a maximum of 15.8% in the low income levels in small towns. Conversely, contingent use in the face of electric power cuts reaches 63.2% of the users. LPG is used for emergencies while kerosene and candles are used on a permanent basis and in emergencies. The permanent use of fuels for lighting only occurs in low income levels while contingent use increases with income. City size does not provoke great changes in electric lighting but it does sharply reduce th permanent use of fuels.

Cooking is associated with a total of thirteen different appliances which use five different energy sources (LPG, kerosene, electricity, firewood and charcoal). This diversity is reduced as income grows; nevertheless, each user has a main appliance which is supplemented by a secondary one in some cases. To this it is necessary to add the barbecue grill used out of doors by about 50% of users.

The LPG cooker covers almost the whole market (96.5%); next comes the kerosene heater which serves mainly as a secondary appliance. The wood-burning "fogón", brazier, open-air wood fire, LPG heater, kerosene cooker, wood burning-cooker and charcola stove are also identified but none of them exceeds 2% penetration, mainly in the low income level. The electric cooker is found only in one city which has been completely rebuilt because the original one was covered by the waters of an hydroelectric dam. Since the power rates continue to be very high they have been substituted mostly by LPG cookers.

The utilization rates vary between 1-2 hs/day for the burners of LPG cookers and kerosene heaters. In the first case the oven is only used 1.3 hs/week. The appliance using less efficient fuels have higher utilization factors (2-6 hs/day). These utilization rates increase with income in the first case and are reduced in the second.

In relation with meal patterns they were found to be very traditional and regular. On the average, the results show 3.28 meals per inhabitant per day, which means lunch and dinner in almost all cases, breakfast in 80%, and tea in two-thirds of family members. City size is inversely correlated with the total number of meals per inhabitant per day.

Water heating is identified with a total of ten different appliances (five are specific for this function and five are cooking appliances) requiring six different energy sources (electricity, LPG, kerosene, alcohol, firewood and charcoal). The electric instant water heater and the cooker

is applicable to about a third of the users, the LPG instant water heater a fifth, and the kerosene heater and the alcohol instant water heater about 10% of the users. The other five appliances reach less than 5% each. Almost all families (97.1%) have the use covered but only 73.3% have specific appliances for it.

As the size of cities decreases we find an increase in penetration of non-specific appliances, a sharp decrease of the electric instant water heater and an increase of LPG instant heater and the electric thermostatic heating tank. In short, penetration of the specific appliances decreases and that of non-specific ones increases.

The utilization rates (hs/day) are two or three times higher in winter and they increase as income level rises.

Air conditioning (space heating). A total of seven different appliances have been identified, five that are specifically geared to space heating and two that are also used for cooking and water heating. They use four sources: electricity, LPG, kerosene, and firewood. This use is only satisfied in 75.7% of the families, using the main appliances: the electric stove, LPG stove, kerosene stove and the kerosene heater. The other three (wood-burning fire place, air conditioner and charcoal brazier) serve only 8% of the total population. These figures show that the winter is short and not very severe. Unlike the cases of cooking and water heating, there exists in each family more than one appliance of each type, specially in those of high income levels and in the small cities.

The daily utilization rate varies between 3 and 6 hs/day during the three winter months. These values are 2 or 3 times higher for the high income level compared to the low income level.

Air conditioning (refrigeration and ventilation) use has a higher average penetration (80.3%) than heating and in all cases reaches saturation in the high income level. Satisfaction of this use increases significantly with income and the size of the cities. Only three types of appliances, all of them dependent on electricity, were identified: fans, turbo fans and air conditioners, each of them available in a great variety of sizes. The first one dominates the market and the air conditioner covers only a small percentage of families (7.7%). On the average each family has about two appliances.

In this instance income levels and climate appear as the main explanatory variables. In the warmer zones and within the highest income levels, the number and size or capacity of the appliances[3] increase for all appliances. Average daily utilization varies between 4 and 8 hours/day, higher than for heating, with an increase as income level, temperature and city size increase. Annual utilization is also about three months a year.

Food preservation has a remarkable penetration in this area where the family electric refrigerator covers 89% of the market. In low and medium income levels there are a few kerosene refrigerators and ice-boxes (2.4% of the total). Although income level and city size have a strong influence on the penetration rate, even with regard to low income levels of small towns, it still reaches 52.6%. Average capacity is about 11 cu.ft. and yearly utilization is practically permanent, except among some low income users who disconnect the appliances during the winter. Conversely, kerosene refrigerators or ice-boxes are only used about four months a year. The existence of freezers are detected in only 1% of the families.

The last use analyzed is domestic electrical appliances, involving seventeen different types, seven of which have significant penetration. In decreasing order of penetration in the market they are: radio (95.2%)[4]; iron, television set, washing machine, record player, polisher and blender (21.4%). The average number of appliances per family is 4.4, ranging between 3.6 at low income levels and 6.2 in the high ones.

Among the seven main appliances, the radio is the only one whose penetration drops as income rises. Saturation at the high or medium income levels is reached only by the iron and television.

It is important to point out the strong penetration of appliances connected with social communication media, even at the low income levels, surpassing the appliances which facilitate household tasks. The iron is the exception, becoming the appliance with most penetration in the medium and high income levels.

Except for radio and television sets, only one apparatus per user has been detected. The influence of income level is positive in all cases and no precise trends are evident as regards

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[3]For fans it varies from 8" to 18", for turbo fans between 12" and for the air conditioners between 1000 and 3500 frigories/hour.

[4]The great majority are battery-operated (83.3%).

city size. The utilization rates are very variable, those used more than one hour a day are the radio (4.4); the television (3.5); the sewing machine (1.4); and the clothes dryer (1.0). In general, utilization increases with income and city size.

The poll has also provided data with regard to individual means of transport, basically the automobile. Its penetration is relatively low (40%) and is heavily influenced by income level; hence the number of vehicles is 4.5 times greater among those who register in the high income level than those who are at the low income level. City size, for its part, also has a positive influence on automobile penetration. In general, there is only one vehicle per family except in high income families, 40% of which have more than one. The average age of a vehicle is 7.8 years, being about 50% lower in the high levels than that of the low levels. Fuel employed is basically gasoline.

The above analysis has demonstrated that a total of fifty different appliances have been identified (not including vehicles), thus revealing the great diversity existing in the urban domestic sector.

The five appliances with the most penetration are the radio (95.7%), LPG cooker, incandescent lamp, electric iron and the electric refrigerator (87.3%). Two of them fall into the category of electro-domestic appliances; one is used for cooking, one for lighting and one for food preservation. The second group of five includes the television set, fan, washing machine, grill (firewood) and record player. It will be noted that among these ten appliances, not one corresponds to water or space heating. Nor is the automobile included in this group. It is important to emphasize that three of the first ten appliances are connected with the satisfaction of entertainment and social communication needs; three with cooking and food preservation; two are related to the personal cleanliness need; one to lighting; and one to refrigeration and ventilation.

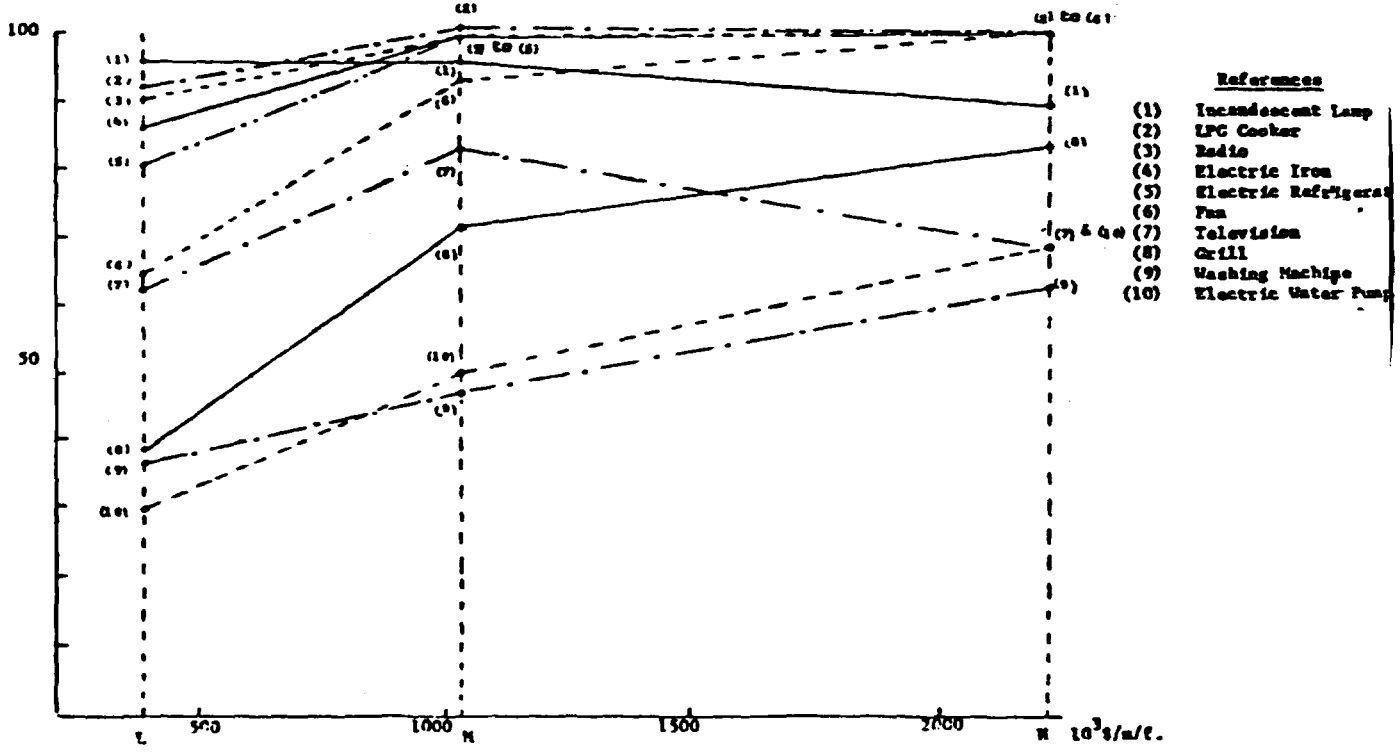
For the great majority of appliances, penetration grows with income level (see graph No. 3). Nevertheless, there are some which appear and may be called "inferior", and for these penetration decreases. In each case this decrease is compensated by the increase of another appliance of a higher quality or one which gives better service. About 46% of the total appliances are present at all income levels. It has been established that about 14% of modern appliances have not yet penetrated the lower income levels while about 30% of lower quality appliances are no longer used (or never were) at the higher income levels. At the low income levels a great variety of appliances of different yields and quality for the same use have been detected, enabling the user to apply the most economic solution to each concrete requirement.

FIGURE 3

URBAN DOMESTIC SECTOR

Penetration of Main Domestic Appliances

(Total for the Province of Entre Rios)



Source: Table No. 4.1.15.

As a summary of the information existing in each of the polls on the acquisition of various sources of energy, the items of equipment available and their utilization factors, a matrix of energy sources and uses has been prepared.

Aggregation of these individual matrices have allowed average consumption rates to be defined per inhabitant and per family and their corresponding structure by sources and uses.

Tables 1 and 2 give the corresponding values expressed in net of final energy and in useful energy. The resulting values in net or final energy vary between 112 koe per inhabitant per year and 163.0 koe/inhabitant/year, according to income level. Measured in useful energy these values are 38.7 koe/inhabitant/year and 74.5 koe/inhabitant/year; in other words, consumption of high income sectors is almost twice that of the low income levels.

At useful energy level, the most important sources are LPG, electricity, kerosene, and firewood. As regards uses, the most outstanding are cooking, water heating, space heating, food preservation and domestic electrical appliances.

With these consumption values per inhabitant and their corresponding structures by sources and by uses, combined with the distribution of the urban population by income level and city size, the values of the energy balance for 1978 were determined, a suitable adjustment with the statistical data being obtained as regards sales of the different energy sources.

Rural Domestic Sector

In 1980 the rural population reached 287,315 inhabitants (30% less than twenty years before) and about 80% were living in dispersed settlements (less than 100 inhabitants). The population decrease occurred because of the reduction in agricultural activities and labour intensity. The migration process was towards large public works and the tertiary sector within the Province, as well as to the federal capital and the province of Buenos Aires.

Rural population in 1980 represented less than 50% in almost all the province. The dispersed population was occupied in agricultural work, cattle raising and winter pasturing, poultry farming for broiler and layer fowl and dairy activities. People living in groups were more connected with the public sector and with trade. The number of dwellings reached 75,983 with an average rate of

TABLE 1

URBAN DOMESTIC SECTOR

Energy Consumption Structure by Sources and Income Level (%)

Energy / Source \ Income Level		NET			USEFUL		
		L	M	H	L	M	H
- Electricity		15.2	25.3	28.1	25.0	38.7	39.7
- LPG in Tubes		7.2	15.7	16.6	9.7	16.7	27.1
- LPG in Bottles		34.1	32.0	27.3	45.9	33.9	27.7
- Kerosene		18.7	10.1	5.1	14.9	8.8	4.4
- Alcohol		0.2	0.1	...	0.2	0.1	...
- Firewood		22.2	15.9	11.1	3.7	1.7	0.9
- Charcoal		2.0	0.9	1.8	0.4	0.1	0.2
- Gasoline		0.1	-	-	...	-	-
- Human Energy		0.4	0.1	-	0.1	...	-
TOTAL	%	100.0	100.0	100.0	100.0	100.0	100.0
	kep / inhab.	112.0	124.0	163.0	38.7	54.1	74.5

Source: PER Long Term Global Energy Planning, Final Report, Volume 12, C.F.I., Bs. Aires, 1981.

...: Values inferior to 0.05%.

- : Null values.

TABLE 2

URBAN DOMESTIC SECTOR

Energy Consumption Structure by Uses and Income Level (%)

Energy / Use / Income Level		NET			USEFUL		
		L	M	H	L	M	H
- Lighting		6.5	5.1	6.4	0.7	0.6	0.7
- Cooking		60.5	43.5	40.4	54.2	38.1	32.6
- Water Heating		10.8	18.3	25.3	14.0	23.2	29.8
- Space Heating		8.8	18.7	13.4	10.1	13.8	11.9
- Refrigeration and Airing		1.0	3.3	3.6	2.8	8.4	9.8
- Food Preserving		6.8	4 .8	4.0	11.2	8.4	7.2
- Other Appliances		5.1	6.1	7.0	6.9	7.4	8.1
- Water Supply		0.6	0.1	-	0.3	...	-
TOTAL	%	100.0	100.0	100.0	100.0	100.0	100.0
	$\frac{kep}{inhab.}$	112.0	124.0	163.0	38.7	54.1	74.5

Source: PER Lon Term Global Energy Planning, Final Report, Volume 12, C.F.I., Bs. Aires, 1981.

... : Values inferior to 0.05%.

- : Null values

3.78 inhabitants per dwelling. Annual average decrease of the rural population in the 1970's was 1.0%.

A total of 161 polls were carried out (2.1 per mil users), covering two bio-geographical zones and three income levels. The main conclusions obtained from these polls are as follows:

Population data are similar to those which emerge from the last census (1980). Family size is slightly higher than the provincial average and increases systematically as family income increases. Almost three-quarters of the family group ar persons over 15 years old. This proportion increases with family income. In accordance with the occupation of the head of the family, the most important activities in the low income level are workmen, non-active persons and clerks; in the medium income level the private tradesmen and non-active persons, and in the high income level, businessmen and non-active persons. Professionals only appear in the medium level and represent a minimum percentage of the total (2%). The EAP is approximately one-third of the total. It increases with income level and is higher than that of the urban area. Average income is 1,190 dollars (1979)/inhabitant/year, with the high-level income average being 4.65 times higher than the low-level one.

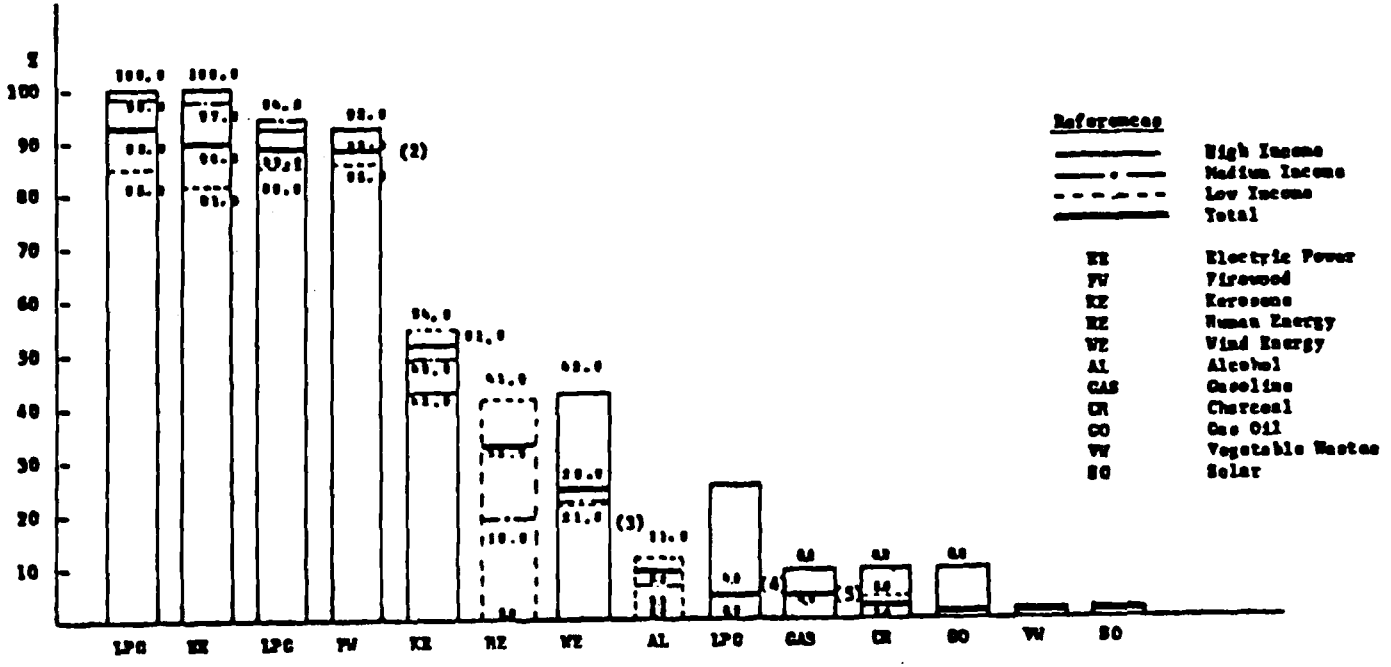
As regards housing, it can be said that with the exception of persons at the low income levels, where 10% live in cottages, the remainder of the population live in houses with an average surface similar to that of the urban area.

The number of rooms and the area of each dwelling increases with income level and the number of persons in a family. The general conditions of the houses are good or fair but almost 40% of the families have no indoor toilets, only 8% have bathtubs and more than a third continue to use unhygienic means for personal cleanliness. In addition, there is a shortage of public services for the supply of drinking water and used water drainage, together with deficient installations in the dwellings. Seventy-five percent of the low income population and half the medium level do not have running water supply and must resort to wells, public faucets or surface water courses. The water tables are ground at a depth of 30 meters. They are abundant and of good quality.

Figure 4 shows the penetration of 12 energy sources used by the rural population. With only 4 of them (LPG, electricity, firewood and kerosene) 80 to 87% of the diversity is covered according to income levels.

FIGURE 4

Province of Entre Ríos
Rural Domestic Sector
Penetration of Energy Sources (1)



(1) Defined as percentage of the families using it, not as participation in the market.
(2) MI and total has the same value.
(3) MI and LI have the same value.
(4) MI and Total have the same value.
(5) LI, MI and Total have the same value.

At the medium level LPG and electricity predominate, both very close to full penetration. Firewood is also very much used (88%) and kerosene retains half the market.

At the high level LPG and electricity reach saturation and the use of firewood is also high (92%). Windmills and kerosene continue to make a significant contribution (about 42%).

The data regarding penetration of electricity may be considerably distorted by the structure of the sample since, according to data of the electricity companies, only 15% of the rural population is supplied with electricity by the public utility. Part of this difference may be covered by their own production.

Penetration of the various uses are shown in Figure 5. It reaches 100% with respect to lighting and cooking, at all income levels. In the medium levels, penetration is also total for hot water and in the high level, other appliances, food preservation and water supply are added. For the total rural population, the order of penetration is as follows: lighting and cooking, water heating, other appliances, food preservation, refrigeration and ventilation, heating and water supply. Penetration of these decreases to the extent that income level decreases. Penetration of individual transport is the lowest in all cases, except for the high income level where it exceeds space heating.

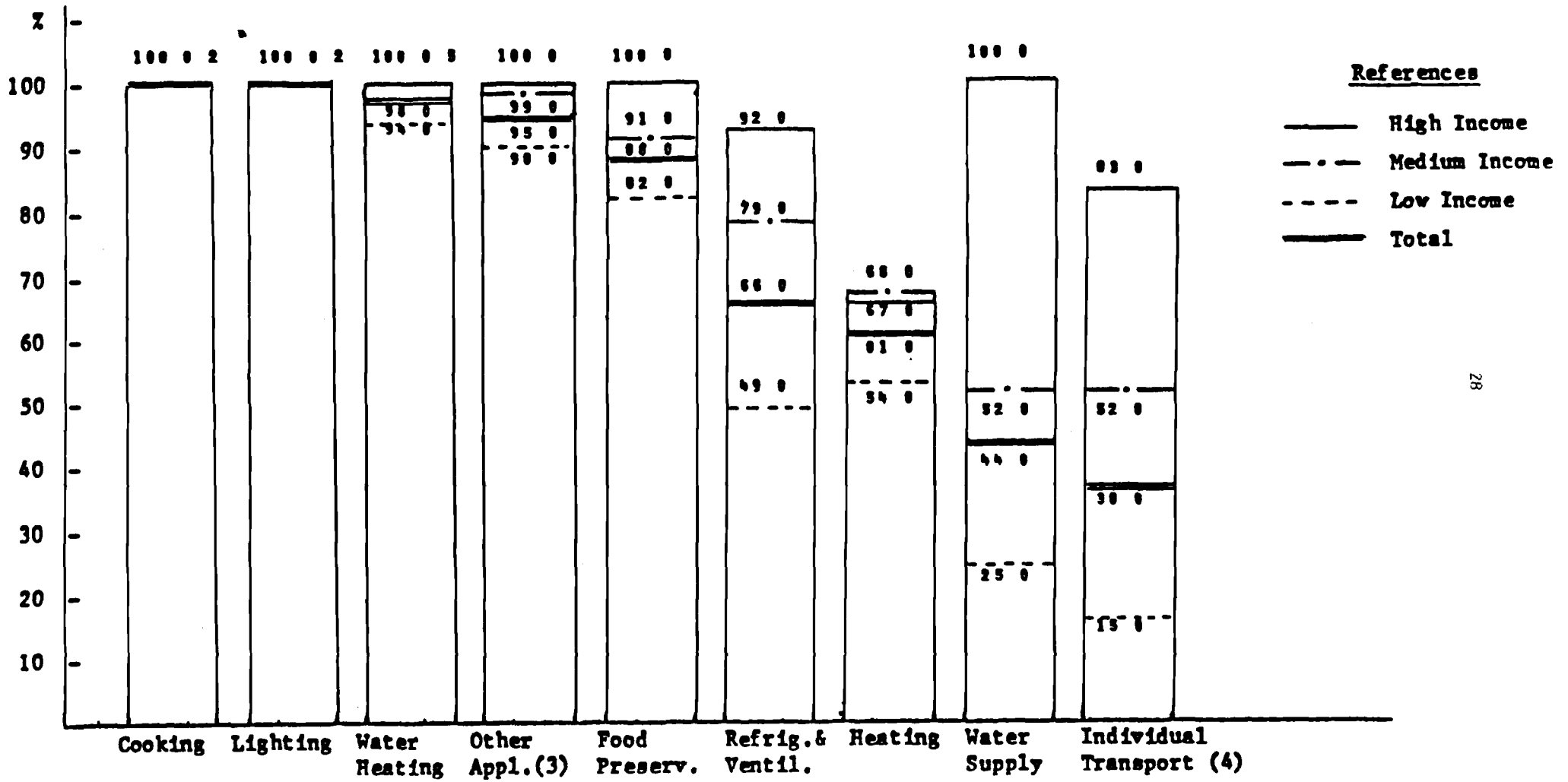
Provisioning of energy sources in the rural area shows that with the exception of firewood and electricity, there are no problems.

Collected firewood is becoming more and more difficult to obtain in view of the gradual disappearance of the woods; this has been confirmed by 50% of the families. Purchased firewood is mainly of the hard type, the cart being the predominant means of transport. Extraction of firewood is carried out mainly by adults (6% are children and 5% the elderly) and half of it is obtained by pruning. Power cuts due to generation and transmission problems are reported by more than 80% of the population. The public service is basically supplied by cooperatives (72%) and the rest by a national enterprise. LPG tubes and gas oil must be fetched by the users themselves, travelling between 15 and 30 kilometers.

For each of the uses analyzed, the following conclusions were reached:

FIGURE 5

Province of Entre Ríos
Rural Domestic Sector
Penetration of Energy Uses (1)



(1) Defined as percentage of the families using it, not as participation in the market.
(2) MI and Total have the same value.
(3) MI and LI have the same value.
(4) Mi and Total have the same value
(5) MI and HI have the same value.

Lighting is electric in the majority of users polled except where there is a lack of supply by the public utility or own production. The poor quality of the electrical service means that 70% of the users are equipped with fuel-powered lighting equipment for emergency use. When there is no electricity, kerosene is basically used (9%) and marginally, LPG (1%). The incandescent electric lamp is the most used (100%), while the flourescent lamp only appears in a third of the users with electricity. This penetration increases sharply with income level.

The most commonly used fuel-powered appliances are the LPG lamp and the kerosene pressure lamp; the common kerosene lamp and candle have a 50% lower penetration than the former. Penetration of the LPG lamp increases with income level while that of the other three decreases. On the average, each user possesses two types of appliance.

Each family using electricity has an average installed power of 434 W, mainly of incandescent lamps. The value increases 87% between the low and high income levels. Average daily use is higher for flourescent (2.65 hours) than for incandescent lamps (1.33 hours) and in both cases there is a tendency to increase with income.

As a consequence, average consumption per day is 603 Wh, being 2.1 times greater in the high income level than in the lower ones. For fuel-driven appliances of permanent use, the utilization rate varies between 1.7 and 3.0 hours/day, and for occasional use about 12 minutes/day.

For cooking the rural family uses about three types of energy per user. In the low income levels firewood and bottled LPG are predominant (more than 81%) and kerosene accounts for one-sixth of that penetration. In medium income levels LPG and firewood are the most important (more than 87% penetration) and kerosene covers only 21% of the total. For high income levels, LPG reaches the saturation level, firewood continues to have more than 80% and kerosene a low 17%. Eleven different types of appliances have been identified. Two of them, the grill and the adobe or brick oven are related to particular Argentine cultural habits, the barbecue and the preparation of bread. The first one appears in 60% of the families and the second in 15%. On the average each user has 2.6 different appliances, the LPG cooker being the principal one at all income levels (80% to 92% penetration). Second place goes to the wood-burning cooker (31% to 33% penetration) which is a very efficient appliance, used also for water and space heating. The kerosene heater and the "fogón" (firewood) come next with penetration varying between 8% and 20%.

Many of these appliances are also used for water and space heating. Only braziers and open fires are used just for cooking. bottled gas cookers and LPG heater are quite specific, but all the others have shared uses. The specific use of each appliance for cooking increases at the same time as income. The combined use of appliances for cooking and watr heating is the most frequent, in particular the wood-burning cooker is used that way by 69% of users. The "fogón", the LPG heater, the LPG bottled cooker and the kerosene heater also have this kind of use. The combined use for cooking and space heating occurs only with the "fogón", the kerosene heater and the wood-burning cooker. Finally, the kerosene heater, the "fogón" and the wood-burning cooker are employed for all three uses in several cases (41% to 81%).

Utilization time (hs/day) is closely linked to specific or multiple use: the more versatile the appliance, the greater utilization time. Then the wood-burning cooker and the "fogón" have the highest values (5.3 and 4.6). Bottled gas cookers, used for dual purposes operate about 2 1/2 hs/day and in the case of kerosene heater its diversified use decreasing with income level is reflected in the utilization time: 2 1/2 hs/day to 1/2 an hour. For the ovens of LPG cookers the weekly hours of use increase with income but the periodicity of use of the grill and the adobe oven (about a week) is fairly constant in relation to income. An estimation of the mean consumption per hours of use expressed in koe shows that the higher values 0.96 (less efficient use) are for the grill, the adobe oven and the open fire. Next come the "fogón" and brazier. The wood-burning cooker is the best firewood appliance. Finally, there is the kerosene heater and the different types of LPG appliance (0.09 to 0.17 koe/hr.).

On the average the rural population prepares 3.3 meals/day, these being breakfast, lunch, dinner and snack. The first and the last in this region are covered sometimes with "mate"[1] which is a widespread habit irrespective of income level and its penetration is about 70%. On the contrary, lunch and dinner at home shows a 95% level with some decrease in the high income levels.

To meet water heating requirements, 13 specific appliances were identified for this use, which are found in about 60% of the families and are powered by six different energy sources (firewood, LPG, electricity, kerosene, alcohol and solar energy).

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[1] An infusion obtained from the leaves of "yerba mate". It is the equivalent of tea or coffee in many homes of the area studied.

A wide variety of cooking appliances is also used, in particular cookers, heaters and braziers. The use is saturated although at different levels in medium and high income sectors and in 94% of the low level. In general, only one energy source is used and one type of appliance per family. In the low income level the sources most used are firewood (47%) and LPG (31%); in the medium LPG (43%), firewood (34%) and electricity (21%); and in the high level, firewood (58%), LPG (33%) and electricity (17%).

With regard to the appliances for all the rural population, the cooker, a non-specific appliance, is the most used (53%) and with the electric instant water heater (17%), the heater (small) and the LPG instant water heater (9% each), covers 88% of the users.

In relation with the utilization rate of specific appliances, it varies from 1.9 hours/day for the LPG thermostatic tank to 0.3 hours/day for the electric instant heater. (One solar heater was identified whose average functioning was estimated at 7 hours/day). Energy consumptions of specific appliances are influenced by the type of source, the yield of the devices, the flow of water and the habits of the population. The estimated values range from 0.69 koe/hr for the wood-burning boiler to 0.15 koe/hr for the electric instant water heater.

Finally, reference should be made to the relatively high installed power required by electric appliances with increases with income (from 1 to 3.5 Kw/user).

For air conditioning (space heating), eleven different types of specific appliances were identified, to which should be added cookers and heaters. They use five different sources (electricity, kerosene, firewood, LPG and charcoal). This need is satisfied in 62% of the households only, without any marked distribution differences as a result of income level.

For this purpose only one source and type of appliance per family is generally used. As regards the latter only 75% are specific for use. The appliances most used are electric heater (25%), kerosene heater (13%) and the LPG heater (7%). Due to the climatic conditions of the area, they are used only during 3.2 months per year with a daily use varying between 2.7 hs/day for the open fire-place and 0.55 hs/day for the electric heater. Specific consumption is very variable, oscillating between a maximum of 1.35 koe/h and a minimum of 0.08 koe/h for the electric heater. Installed power in electric appliances rises from 1.0 to 1.4 kw per usr as income increases.

Penetration of air conditioning (refrigeration) is slightly higher (67%) than that of space heating and, unlike the latter, it grows significantly with income level (from 49% to 92%). Only three different types of appliances have been identified, all of them electric, but with a wide variety of sizes or capacities. The most frequent is the fan (61%) followed by the turbo-fan (7%). The air conditioner only appears in about 8% of the high income level. For the first, the most frequent size is the 16" model and for the latter, average power reaches 2700 frig/appliance. Average utilization rate is from 1.0 to 1.6 hs/day during 3.3 months/year, average installed power varies from 0.2 kw for fans to 2.7 kw for the air conditioners, specific consumption being proportional to these values.

Penetration of food preservation in the rural area is as high as in the urban area. It reaches 86% for all income levels and saturation is achieved at the high income level. Only one type of appliance, the refrigerator, was found in this use, with two different energy sources, electricity and kerosene. The first covers 81% of the users with increasing participation as income increases and the second covers the difference. Refrigerator capacity varies from 7 to 14 cu.ft., about 12 cu.ft. being the most frequent. The average power capacity is 0.14 kw, increasing from 0.13 kw to 0.21 kw as income increases. The utilization rate is almost all year round for the electric refrigerator but only 9.7 months/year for the kerosene one. This implies an average consumption of 20.6 koe/year/user for the electric refrigerator and 301 koe/year/user for the other. Not one freezer has been identified.

In the rural area an important use is pumping for water supply, because of the low penetration of public water services, its average penetration being 73%. In high income levels it reaches saturation. Four different methods have been identified: electric pumps (46%), manual pumps (32%), wind pumps (23%) and gasoline pumps (4%). The electric (50%) and wind (42%) pumps predominate in high income users, and the manual (55%), electric (46%) and windmill pumps (28%) in the low income levels.

Average power is 0.1 kw for windmill pumps, 0.6 kw for electric and 2.2 kw for gasoline ones.

Utilization rates vary between 1 and 2 hs/day and the yearly consumption is equivalent to 5.4 koe for the windmills, 23.0 koe for the electricity pump and 437 koe for the gasoline engine.

Other appliances refers to the equipment for cleaning and maintenance of clothing, house cleaning, preparation of food and family recreation, both electric and otherwise. On the average the

users have 3.4 appliances out of a total of 12 different appliances identified. The penetration of at least one appliance is 100% except for the low income group which demonstrates only 90%.

Considering each appliance separately, the iron and the radio take first place (85-83%), then comes television (60%), washing machine (48%), record player and blender (19-18%). It can be seen that out of 6 appliances there are 3 which are connected with family recreation and social communication, two with cleaning and care of clothing and one with food preparation. This rating is practically the same as that of the urban area, with the sole exception of the floor polisher, but whose penetrations are somewhat lower in all cases.

Penetration increases with income in all cases, particularly for record players and blenders. To a lesser extent penetration of television and washing machine also increases to almost 90%. Generally, each family possesses a single appliance of each type, except for the iron, the television and the radio. The majority of the appliances are electrically operated but there are alternative drive sources in several cases, this situation being different from the urban area. In accordance with the polling, there are battery-operated radios and television sets, LPG or charcoal irons, and gasoline powered washing machines. In no case do these alternative sources represent more than 7% except in the case of battery-operated radios which represent 91%.

The utilization rate is high for the communication appliances (5 hs/day for radio and 3.3 hs/day for television). The electric iron and washing machine are used half an hour on average. For the others, the use is about 1.5 hours per week. In all cases the utilization rate increases with income. Total installed power for the electrical equipment is 0.9 kw/family on the average, while for the high income levels it is twice that of the low. Annual estimated consumption varies between a maximum of 190 kw for the clothes dryer and a minimum of 4.4 kw for the blender, at average rates.

By way of synthesis, an estimate of total installed power of all types of electric appliances was made, giving an average value of 2.58 kw/family, which varies from 2.09 kw for the low income levels and 4.10 for the high.

Out of this total, 34% corresponds to other appliances, 20% to water heating, 17% to lighting and 12% to space heating.

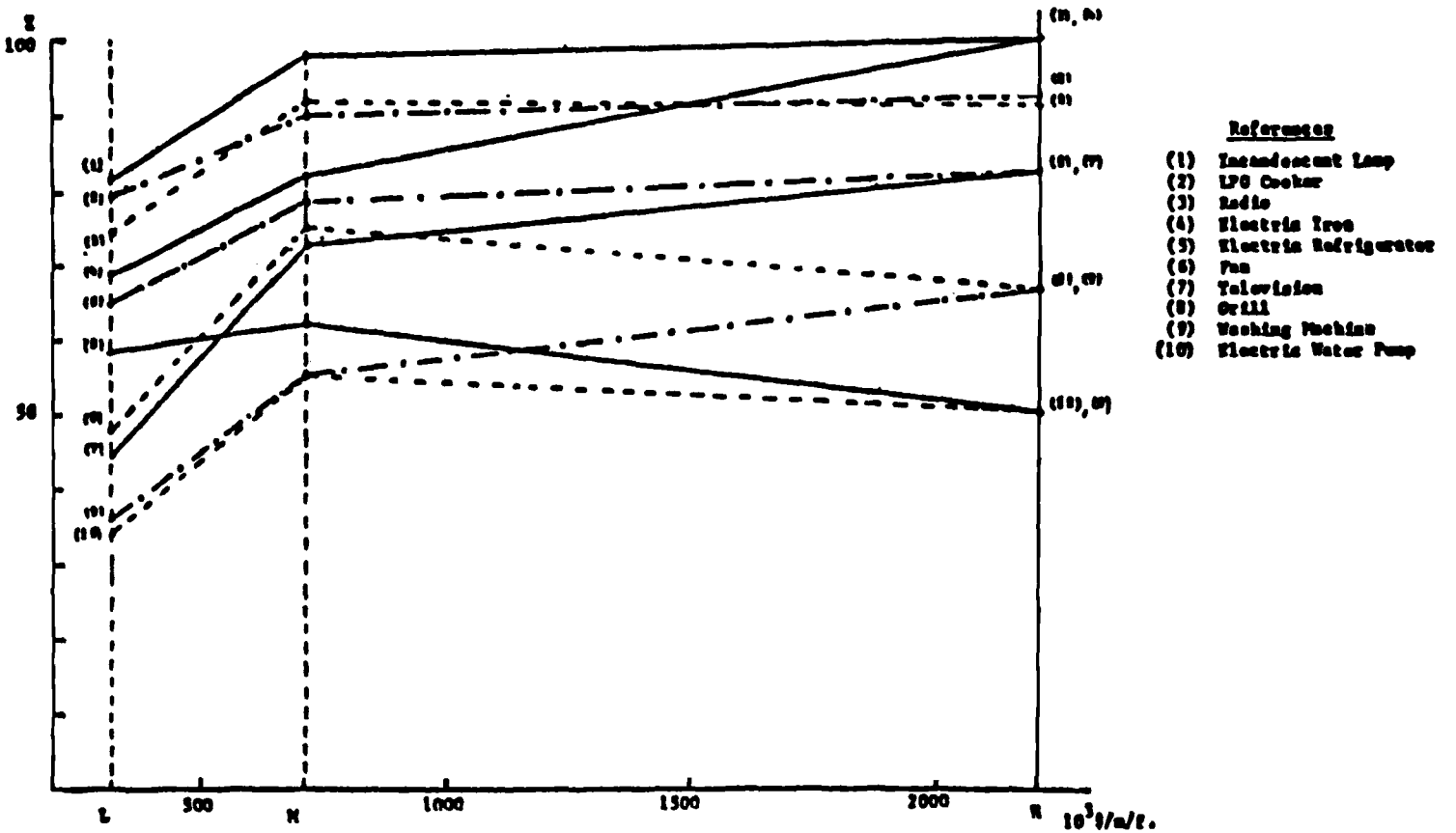
The poll also requested information on the individual means of transport. The results obtained showed that altogether seven types of vehicles were identified: four were motorized and three operate on the basis of muscle energy. In 76% of the families, there was at least one of these types of vehicle. Maximum penetration corresponds to the automobile (38%) and the pick-up (28%) among the motorized means of transport, and to the horse (19%) and the sulky or cart (16%) among the non-motorized. For the former, penetration increases with income but without reaching saturation, while it decreases for the latter. Except in the case of the horse in which about 62% of the families have more than one, there is an average of only one to each family for the other means of transport. Average age of the automobiles and pick-ups is almost 15 years, for trucks and motorcylces it is around 20 years. In general, it decreases with income level. The automobiles are almost totally gasoline-driven, the pick-ups about 84% and the trucks about 50%. The remainder use gas oil.

For the motorized vehicles the average distance travelled varies between 50,000 km/year for the trucks and 3,600 km/year for the motorcycles. In the non-motorized means it is much less, averaging about 1,310 km/year for the horse and 400 km/year for the bicycle. In relation with the public transport, about 39% of the families have an inter-city service available with a mean frequency of 5 vehicles/day.

As a summary of all uses, it can be said that a total of 59 appliances have been identified (not including vehicles) and 32 of them have penetration higher than 10%. The five appliances with the most penetration are the incandescent lamp (90%), LPG cooker, radio, electric iron and electric refrigerator (72%). Next are the fan (61%), television, grill, washing machine and the electric motor pump (46%). Among these 10 most important appliances those related to heating (water or space) do not appear, nor does the automobile. The above 10 appliances figure among the most important at all income levels, although in the high level the automobile and the flourescent lamp reach penetration similar to those of the refrigerator. With the exception of the fan, the grill and the electric water pump, all the other appliances of this group increase their penetration with income level (Figure 6). It is important to emphasize that in this area the appliances metnioned above are connected with the satisfaction of personal hygiene needs in three cases, with cooking and food preservation in three cases, with entertainment and social communications needs in two cases, and the other two appliances are related to lighting and ventilation. At the low income level, there are 13 high cost appliances which do not penetrate the market, while 12 appliances of low performance and/or low quality have disappeared or were never used by high income level

FIGURE 6

Province of Entre Ríos
Penetration of Main Appliances
Total Rural Domestic Sector



Source: Table No. 4.2.20.

households. There are another five that were absent probably because of the relatively low number of polls in this level. In the medium income level only 3 appliances were absent.

As a summary of each poll, a matrix of energy sources and uses was prepared. Aggregation of these individual matrices allowed averaged consumption rates to be defined per inhabitant and per family, and their corresponding structures by sources and uses. Tables 3 and 4 show the respective values expressed in net or final energy and in useful energy. Net consumption per inhabitant is 215.1 koe/yr for the low income levels, 195.8 koe/yr for the medium and 234.5 koe/yr for the high income levels. This apparently abnormal behaviour is due to the low yield of the sources used in the first group. Expressed in useful energy the respect values are 42.7 koe/yr for the first two groups and 72.5 koe/yr for the third group. In terms of useful energy, the most important sources are LPG, firewood, electricity and kerosene. The four of them together provide 97.3% of the total useful energy. As regards uses, cooking appears to be the most important, followed by water heating, space heating, food preservation and other appliances. These five uses together consume about 95.2% of the total useful energy.

With these consumption values per inhabitant and their corresponding structures by sources and uses, combined with the distribution of the rural population by income level, the values of the energy balance for 1978 were calculated together with the urban area data, they matched the statistical information available on sales of the different energy sources very well.

Commercial and Services Sector

This sector includes a great variety of activities with widely different characteristics. In this particular case the 139 polls carried out refer to nine different activities: wholesale trade (WT) and retail trade (RT), repair shops (RS), laundries (L), hospitals (HS), schools (SCH), hotels (HT), restaurants (R) and bars and cafeterias (B-C). Some of these activities are over-represented in the sample in relation to their real participation in the sector because they have a more important energy consumption. Because of this and the great diversity of activities within the sector, it was preferable not to draw conclusions for the total but instead for each of the activities independently. The polls cover establishments in both the urban and rural areas and the conclusions will be given for the whole, with comments as necessary.

In order to characterize the activities mentioned, some significant parameters were analyzed by establishment, such as:

TABLE 3

RURAL DOMESTIC SECTOR

Energy Consumption Structure by Sources and Income Level
(%)

Energy / Income Level / Item		NET			USEFUL		
		L	M	H	L	M	H
LPG in Tubes		0.0	0.8	10.9	0.0	1.3	16.3
LPG in Bottles		15.4	21.1	13.7	33.9	38.8	19.4
Kerosene		17.0	11.6	6.0	11.1	9.1	3.7
Alcohol		0.2	0.2	0.0	0.3	0.2	0.0
Gasoline		0.5	0.7	1.1	0.3	0.4	0.5
Gas Oil		0.0	0.0	5.7	0.0	0.0	11.0
Firewood		60.8	55.8	50.5	39.4	28.3	24.2
Charcoal		0.4	0.0	0.4	0.2	0.0	0.1
Electricity		5.1	9.8	12.0	14.3	21.7	24.7
Wind		0.2	0.1	0.2	0.1	...	0.1
Human		0.9	0.3	0.0	0.4	0.1	0.0
Solar		0.0	...	0.0	0.0	...	0.0
Total	%	100.0	100.0	100.0	100.0	100.0	100.0
	Kpe / inhab./year	215.1	195.8	234.5	42,78	42.71	72.55

TABLE 4

RURAL DOMESTIC SECTOR

Energy Consumption Structure by Type of Use and Income Level
(%)

ENERGY / ITEM / INCOME LEVEL		NET			USEFUL		
		L	M	H	L	M	H
Lighting		5.7	3.3	2.6	0.8	0.6	0.4
Cooking		62.2	59.4	57.3	63.3	55.0	42.9
Water Heating		10.7	12.4	15.1	11.5	13.6	17.3
Space Heating		8.0	11.2	12.3	9.7	10.9	18.8
Space Refrigeration		1.7	0.6	2.0	1.3	2.2	6.8
Food Preserving		8.2	8.4	6.1	7.5	9.5	7.1
Water Supply		1.7	1.5	1.6	1.7	1.8	1.5
Other Appliances		1.8	3.2	3.0	4.2	6.5	5.3
TOTAL	(%)	100.0	100.0	100.0	100.0	100.0	100.0
	$\frac{\text{Koe}}{\text{inhab.year}}$	215.1	195.8	234.5	42.8	47.2	72.6

- Number of personnel - varying between 142.8 for hospitals and 2.6 for laundries.

- Covered surface - highest for hospitals with 2,935 sq.m.; and lowest for bars and cafeterias, only 80 sq.m. The average number of rooms is lowest for repair shops (1.2) and highest for hospitals (88.5); hotels indicate (51.6) and schools (42.3).

- Annual operation - hospitals and hotels can be distinguished as functioning every day of the year; restaurants, bars and cafeterias with an average of 6.5 days per week; schools functioning only 216 days a year and the remaining activities about 300 days a year.

- Daily hours of work - the hospitals and hotels operate 24 hours; restaurants, bars and cafeterias and retail trade with 13 to 10 hours a day and the rest about 8.5 hs/day.

- Water - in practically all cases the establishments have water through the public service with the exception of some schools, retail trade establishments and restaurants in the rural area.

In relation to the penetration of different energy sources, it was found that only bottled LPG and electricity are used in all activities, the latter at saturation level in all cases. Bottled LPG has maximum penetration (92.9%) in hospitals and it is minimum in repair shops (40.4%). In between there are the restaurants, bars and cafeterias, wholesale trade, schools, hotels, laundries and retail trade. LPG in tubes is used in six activities (RT, RS and L do not use it), going from 92.9% penetration in hospitals to only 13.3% in bars and cafeterias. Next comes kerosene with penetration between 28.6% in hospitals and 3.3% in retail trade. The exception is laundries (75.0%) because it is used in small steam generators boilers instead of gas oil. Firewood is identified also with six activities (RT, WT and RS do not use it), with use penetration between 35.3% in restaurants and 9.5% in schools. Gas oil, diesel oil and fuel oil are used only in two or three activities and with low levels of penetration (4.5 to 22.7).

In the main report there is also additional information about supply characteristics (annual, winter and summer consumption, institutional supplier, etc.) for each activity. With regard to energy use penetration it can be stated that only lighting is always present at saturation level. Cooking reaches saturation level for hospitals, restaurants and for bars and cafeterias. Schools and hotels have penetration of 62% and 54%. In the remaining activities cooking refers mainly to

preparation of hot drinks (tea, coffee, mate). It therefore represents a low energy consumption even if penetration is high.

Water heating is a widespread use in hospitals (100%), hotels, restaurants and schools (76%). For bars and cafeterias it reaches only 47% and 20% for repair shops (RT, WT, RS do not use it).

Space heating is present in all activities (except RS) but with very wide penetration levels. It is at the saturation level only in hospitals and has the lowest penetration (12.5%) in laundries. In between ranges: hotels, schools, restaurants, bars and cafeterias, wholesale trade and retail trade.

Conversely, refrigeration and ventilation reach saturation level in four activities (laundries, hospitals, hotels and restaurants). It is not functional in repair shops and has intermediate levels of penetration in wholesale trade, bars and cafeterias, schools and retail trade (60.0%).

Food preservation also reaches saturation level in hospitals, restaurants and bars and cafeterias. Then come hotels, wholesale trade, retail trade, school, repair shops and laundries (12.5%).

Other appliances also reach saturation in three activities: repair shops, schools, and hospitals. Then there are restaurants, retail trade and wholesale trade. This category of use penetration really corresponds to very different types of appliances in each activity.

Water supply is present in almost all activities (except RS and B-C) but with very low penetration. It refers mainly to water pumping from the public service into intermediate storage tanks in high buildings. Finally, process heat appears only in wholesale trade and repair shops. The activities with a greater variety of use are hospitals, hotels, restaurants, schools and wholesale trade.

On considering the different uses in greater depth, the polls give information about the penetration of each appliance and structure of appliance stocks. The main conclusions by activities are as follows:

Lighting. It is 100% electric in all the activities but between 23% and 36% of establishments have also fuel burning appliances; mainly LPG lamps for emergency service. This situation is more frequent in rural than in urban areas. Electric lighting uses both incandescent and flourescent lamps with an equal distribution of about 50% each, except in schools and hotels where the former predominates and in retail trade where the latter are more frequent. The installed power per square meter is about 3-4W except for bars and cafeterias (20 w/sq.m), restaurants, hotels and hospitals abut 7.5 w/sq.m. In general, 60W incandescent bulbs and 50W flourescent tubes are used.

Cooking. This use is present basically in hospitals, restaurants, schools, bars and cafeterias and only marginally in commercial activities and repair shops. As regards hotels and schools, about half of them show evidence of this activity. The diversity of appliances is rather high: eleven different types have been identified, cookers, both industrial and domestic ones, and ovens have greatest penetration. Grills, deep friers and coffee machines attain a certain importance in restaurants.

Water heating. For this use five different types of appliances were identified (boiler, thermostatic tank, instant water heater, cooker and heater), their penetration being considerably different according to the activities. Except for repair shops (that use cookers only), several appliances are present in each activity according to the different uses given to the hot water.

Space heating. In this case seven different appliances were identified, the most frequent being the electric, LPG and kerosene stoves. Hospitals and hotels also have boilers (used also for water heating) and wholesale trade establishments, hospitals and hotels have air conditioners.

Refrigeration and ventilation. Four different appliances (fan, air conditioner, turbo-fan and air extractors) have been identified in the different activities (except repair shops). In all activities the fan has highest penetration followed by the air conditioner (when the use is present). The other two have very different levels of penetration. In general, penetration of the appliances is lower in the rural areas.

Food preservation. Three out of six identified appliances are the most used: family and commercial refrigerators and food preservers. In some activities, freezers, cold storage houses and ice cream machines, were found but with very low penetration.

For water supply only electric pumps are used. This use is basically intended for pumping water from the public service to intermediate storage tanks mainly in urban areas and for obtaining under-ground water in some rural establishments.

For other appliances it is very difficult to make any generalization because they are very specific for each activity. The greatest diversity is found in hospitals, with 15 different categories. Next come retail trade, schools, restaurants and hotels with approximately nine. Laundries have only two and the others between three and five categories. Saturation is not reached for any of them (except the iron in hospitals, electronic equipment in schools and special electric equipment in wholesale trade).

Process heat was detected only in wholesale traders and laundries. In both cases boilers of different types are used in all the establishments.

In the main report there are also several tables giving the main characteristics of each appliance: average number of appliance per establishment, energy source, size and use intensity. On the basis of the information gathered from each poll in each activity their energy consumption by source and use has been calculated at the net or final energy level and at the useful energy level, bearing in mind the utilization yields of the appliances used in each case.

For wholesale traders process heat (90%) and other appliances (8%) represent the main uses that are satisfied with fuel oil, diesel oil and electricity. LPG and kerosene together do not reach 1%. At the useful level the participation of electricity increases. In retail traders the main energy source is electricity, both at net and useful level, which is used for food preservation, other appliances, lighting and refrigeration and ventilation. Due to the low yield of lighting and the high yield of air conditioners the importance of these uses changes at the net or useful level.

In repair shops, 94% of energy consumption is related to other appliances and lighting, satisfied basically with LPG and electricity. At the useful level electricity represents 64% of the total.

As regards laundries, 97% of the net energy consumption is for steam generation for pressing, for which firewood, kerosene and gas oil are used. Electricity is used in washing and drying

machines and in lighting but represents less than 2%. At the useful level this participation of electricity and other appliances increases and that of firewood is reduced.

In schools the main uses are cooking, water heating, space heating and lighting that are satisfied with LPG (75%) and electricity. There are no great differences between net and useful level except for lighting.

As regards hospitals 90% of energy used is for space and water heating, cooking, and other appliances. There is a great variety of sources, fuel oil, LPG, electricity and gas oil being the most important at net energy level. At useful level electricity takes second place due to its high yields in all uses (except lighting). In hotels water and space heating represents 87% of the total and in relation to energy sources gas oil, diesel oil and fuel oil cover 70% of the total with electricity, firewood and LPG coming next.

In restaurants the most important use is cooking (85%). Water heating, food preservation, lighting, refrigeration and ventilation and space heating get less than 5% each. The main energy source is LPG (79%) and then firewood and electricity at the net energy level. At the useful energy level participation of LPG and electricity increase significantly and that of firewood is reduced to only 1.4%.

Finally, for bars and cafeterias cooking is the predominant use (75%) complemented by food preservation, lighting, space heating and refrigeration and ventilation. The main energy source is LPG (67%) and then come electricity and firewood at the net energy level. The order between the last two changes at the useful energy level because of the low yield of firewood.

As in the other sectors all this information was the basis for estimating the sector energy balance for 1978 in net and useful energy by uses and sources.

Industrial Sector

The area studied is more an agrarian one with some industrial and mining activities. Large scale industrial activities began from the '40's onwards with packing plants, the dairy industry, the food industry and a cement plant. According to the last National Industrial Census (1974) the area held sixth place (out of 24 political subdivisions) in number of establishments, seventh in

persons employed, and eighth in added value. The industrial sector is especially developed in food products; drinks and tobacco; timber and manufacture of non-metallurgical ore branches (packing plants, grain in saw mills and cement plants). The industrial added value dropped its share of the GGP from 25% to 15% between 1963 and 1977. From within the evolution of the industrial sector we can see stagnation of cement production, an increase in vegetable oil, wheat and rice milling and paper production and a decrease in almost all other branches. As regards mining activities, they represent 2% of GGP specially for the production of non-metallurgical ores and application rocks. For this branch the area occupied third place in the country.

A total of 199 polls were taken which covered 80% of the added value and 6.2% of establishments from divisions 31 to 38 of the Uniform International Classification (UIIC). The selection of establishments and the grouping of polls were made at the five digit level of the UIIC.

The analysis covered all the energy sources and the different uses (process heat, electricity and non-electric power and lighting).

The processing of these polls gave the following results in connection with the main variables characterizing the activity of each branch and their energy consumption by source and by use. The values obtained are given in detail in the main report for each of the 39 branches identified at the five-digit level of the UIIC. Only the average and extreme values determined for each variable will be mentioned here. In general, in the majority of cases, a wide dispersion for a small number of establishments in each branch was found, in spite of having covered in many cases all the establishments which exist in the area.

The production weighted average, for the covered area by establishment is 3,832.5 sq.m., the ratio between standard deviations and average being very high (1.78) which shows great dispersion. The simple average worked hours by establishment is 3,901.6 hs/yr with a relatively low dispersion coefficient (0.62). The majority of the establishments operate 44 hours a week and according to the type of activity works all year round or only some specific months, giving an average of 11.6 months/year. Total number of persons employed, both workers and administrative, technical and management, are 100 on the average with a high dispersion (2.08) ranging from 1 to 1224 persons/establishment. The most frequent rates are those corresponding to 11-20, 1-20 and 101-200 persons. Combining the two previous variables we can obtain the man-hours worked per establishment. Weighted with production an average value of 250,000 man-hours is obtained with a dispersion

coefficient of 1.92. This variable gives an idea of the most important industrial branches (food and textile) in the area from the occupational point of view.

If the importance of the main product in relation to the total production of each establishment is measured, a value of 0.818 with a very low dispersion (0.25) is found which indicates a high degree of specialization in a single product and therefore a high inflexibility of the activity. On the other hand, the main raw material related to total inputs gives an average value of 0.912 with a very low dispersion (0.13). These two aspects show that a majority of the industrial activity in the area is based on the transformation of a basic input to obtain a main product.

The poll also contains data on installed production capacity and real production in the year of the polling. Since the units are not homogeneous, it is not possible to make an average for all the sector but in each branch the diversity of values is very great. In relating production to capacity, a utilization index of 64.3% is obtained, with a dispersion ratio of 0.35, which shows that the conjunctural crisis at the moment of the poll was quite generalized. Another indicator of the critical situation consists of expansion plans, since in 58% of the branches polled less than 50% of the establishments projected any type of expansion and in only 26% of the branches did all the establishments have some plans in this connection.

An attempt was also made to identify the generation of waste for potential energy uses. They were detected in only 13% of the branches in which only 25-50% of the waste was used as fuel.

Finally, the general energy consumption, heat and power, was calculated and measured in net or final energy, the result for the whole of the branches being 144.2 koe/ton of product with a relatively large variability (DS/mean = 1.30). If the analysis is made at establishment level, the variability is even greater in function of the diversity of processes, technologies and sources used. For the mining activity a relatively low level of energy consumption (1.3 to 6.7 koe/ton) was found.

In the main report detailed information is given on the structure by sources of this total consumption and for each specific use (process heat, non-electric power, electricity by self-production) in each of the 38 branches. Some comments in connection with this information are as follows:

- The share of firewood in raw mills (92%), bakeries (86.5%), brick production (72.9%), gypsum production (82%) and in the tanning industry is very important.

- Although proper promotion is lacking, biomass wastes are used as fuel in the rice milling and the vegetable oils activities.

- LPG, kerosene and gasoline are very little used in the province for industrial purposes.

- The fuels with greater relative incidence are gas oil, diesel oil and fuel oil, both for process heat and power.

- Electric supply in the industrial sector is basically provided by the public utility and either the national enterprise or cooperatives, according to the location of the establishment. Self-production also exists in only 13 of the 38 branches analyzes. This is normally connected with the simultaneous generation of electricity and steam, with ensuring reliability of supply or with availability of vegetable wastes. In 9 of the 13 branches with self-production, this is only on the basis of diesel generating sets and it is in this sector where an improvement in the public service could lead to elimination of self-production.

On classifying the establishment of each branch by the annual electricity consumption level, the majority are found to be small and medium with consumptions of less than 0.58 Gwh/year or between 0.58 and 11.6 Gwh/year. Only in the branch vegetable oil do establishments appear with large consumptions (from 11.6 to 58.1 Gwh/year). In nearly all the industrial branches process heat is the main use except in mining activities where it does not exist and meat packing houses, wheat mills and the tobacco industry where power is most important. The power is supplied in almost all cases by electricity (except in mining), being mostly supplied by the public utility. Self-production is important in meat-packing houses, wheat mills, ice factories, cement and mining activities.

On analyzing penetration of the different energy sources in each branch, the following conclusions are reached:

- There is high penetration on the part of the public electricity services.

- The little use given in rice milling to biomass wastes as fuel. Only 17% of the establishments make use of it.

- The high penetration of fuel oil in most of the important branches.

On the basis of the above information, consumption by source and by use matrices were made for each activity, both as net and useful energy levels. Tables 5 and 6 summarize the results for the whole of the industrial and mining sector. The main conclusions to be drawn from them are the following:

- The industrial activities of the province use 85% of the total energy consumed for process heat showing the predominance of the food industry and cement production.

- The remaining 15% for power (and lighting) of which 83% is electric. Steam machinery only subsists in the timber industry and represents barely 2% of the total power. Non-electrical power is used basically in the mining activities and the diesel engine is the most important.

- Fuel oil with 75% of total energy consumption is the basic energy source. Electricity occupies second place with 12.3% and firewood is third with 7%.

- At useful energy level, the participation of electricity increases to 18% while that of firewood drops to 5.2%, without changing its relative importance.

Rural Production Sector

This sector includes agricultural, cattle-raising and forestry activities connected with production, harvesting, treatment and transport of food, industrial crops and forestry resources to warehouse.

The main uses of land in the province show that 71% of the total (6.9 million ha) is assigned to cattle raising, 18% to agriculture, 2.2% to natural and artificial woods and 0.2% to farms. Unsuitable and unused land covers the rest. In the latest available census (1974) rural exploitations totalled 60,257, of which 47.8% were for cattle raising, 30.3% for agriculture, 9.2% for farming, 6.7% for dairy production and the rest for fruit growing, forestry, vegetables and others.

TABLE 5

INDUSTRIAL SECTOR AND MINING

Structure of Net Energy Consumption by Source and Use
(%)

Uses \ Sources	FW	BW	LG	MG	KE	GO	DO	FO	CH	CK	EE	TOTAL	TOTAL
Process Fuel	8,1	1,0	0,4	-	...	3,3	3,8	83,1	0,2	0,1	-	100	85,2
Steam Machinery	43,6							56,4				100	0,3
Diesel Engines						100						100	2,0
Gasoline Engines				100								100	0,2
Electric Power and Light											100	100	12,3
TOTAL	7,0	0,8	0,3	0,2	...	4,8	3,2	71,2	0,2	...	12,3	100	100

FW: Firewood
BW: Biomass Wastes
LG: Liqueted Gas
MG: Mining
KE: Kerosene
GO: Gas Oil
DO: Diesel Oil
FO: Fuel Oil
CH: Charcoal
CK: Coke
EE: Electric Energy

TABLE 6

INDUSTRIAL SECTOR AND MINING

Useful Energy Consumption Structure by Source and Use
(%)

Sources / Uses	FW	BW	LG	MG	KE	GO	DO	FO	CH	CK	EE	TOTAL	TOTAL
Process Fuel	6,4	0,5	0,4	-	...	3,1	3,9	85,5	0,2	...	-	100	80,74
Steam Machinery	40	-	-	-	-	-	-	60	-	-	-	100	0,2
Diesel Engines	-	-	-	-	-	100	-	-	-	-	-	100	1,0
Gasoline Engines	-	-	-	100	-	-	-	-	-	-	-	100	0,06
Electric Power and Light	-	-	-	-	-	-	-	-	-	-	100	100	18,0
TOTAL	5,2	0,4	0,3	...	...	3,5	3.1	69,3	0,2	...	18,0	100	100

FW: Firewood
BW: Biomass Wastes
LG: Liqueted Gas
MG: Mining
KE: Kerosene
GO: Gas Oil
DO: Diesel Oil
FO: Fuel Oil
CH: Charcoal
CK: Coke
EE: Electric Energy

In connection with the economic value of this sector it can be said that at the time of the polls it provided 20% of the GGP. Within the sector, cattle raising represents 66.9% of the added value, agriculture 31.9% and forestry 1%. For the first group, animal raising is the most important (90%), dairies represent 9% and farms the rest. Beef cattle ranches in the north of the province are engaged in breeding while those in the south are devoted to fattening and wintering livestock. Sheep farming is also to be found in the north. Part of the beef cattle is slaughtered for local consumption, another part is industrialized and exported, and a third is sent on the hoof to the rest of the country. Dairy farming has grown very considerably in the last 20 years up to 100 million litres/year.

Within agriculture, the most important cultures are cereals (37.4%), citrus fruit growing (30%), and fodder (22.3%). The rest is devoted to oil seeds, vegetable gardens and industrial crops. In general, the agricultural yields are less favourable than the national averages except for rice (25% higher). Citrus fruit growing is very important, the province being one of the four main production areas of the country. Poultry farming reached the highest level in 1972-73 and has since declined. Forestry has acquired more importance due to a forestation the cellulose industry based on credits and tax incentives. In some cases forestry has substituted land intended previously for agriculture and cattle raising.

The sector was surveyed through 102 polls for activities developed in 73 establishments. These polls represented a coverage of 2 per thousand of the total number of establishments. In view of the particular characteristics of each activity, six different questionnaires were drawn up.

The information collected and processed for each activity refers to general aspects of the establishments, main production inputs, energy supply, problems and prospects of energy supply, value of the productions sold, structure of energy consumptions at net and useful energy level by source and for each cultivation sector. As for the energy sources, in addition to the commercial ones, human and animal power and the energy equivalent for fertilizers and other agrochemicals production were also taken into account.

In the main report[5] a detailed analysis is given of the results obtained for each of the items previously indicated and for each of the 10 activities polled.

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[5]A Regional Energy System, The Entre Ríos Province (Argentina) Report No. 1, Volume III, IDEE, December, 1982.

We shall not go into the same degree of detail here, but instead shall transcribe the main general conclusions for the whole of the sector.

From the total area of the establishments polled, the average results show that only 63% is under exploitation. Of the remaining territory, 19% is covered with brush and 13% is not used. The average is 369 hectares, with a minimum of 11 hectares for horticulture and a maximum of 572 hectares for cattle raising. About 70% of the land covered with brush is used by citrus fruit farms. Conversely, in horticultural, cattle raising and agricultural establishments less than 2% of the land is unused.

The land tenure structure of the establishments and the land area show that 86% are exploited by their owners, 13% by tenants and only 1% by other means.

The total installed power per hectare on the average is 1148 HP. Only 0.8% is animate power and 99.2% is mechanical or electrical power. This data shows that the rural production sector is highly mechanized, especially in the rice activity.

The irrigated area is only significant in the case of rice, for which about 77% of the total planted area is irrigated. This is followed by the vegetable gardens (50%), and far behind the citrus farms (with only 2%). The use of fertilizers and other agrochemicals is very low except for citrus fruit farms and rice cultivation.

Electric energy is used in 36% of establishments, 20% of which are self-producers. High prices and frequent power cuts are the main problems preventing the increase of electric consumption from the public network.

From the economic point of view the average income per hectare is highest for citrus fruit growing (187.3 US$/ha) and lowest for dairy activities (122.5 US$/ha). As income per hectare is concerned, the animal rearing activities, both poultry and cattle, are the highest (396 and 362.6 US$/tn) and forestry is the lowest (18.8 US$/tn).

The energy consumption structure in net and useful energy by source and use for the whole sector can be seen in Tables 7 and 8.

TABLE 7

TOTAL RURAL PRODUCTION SECTOR

Consumption Structure of Net Energy by Source and Use (1)

Uses / Energy Sources	Human Energy	Animal Energy	Fertil.	Other Agro-chemicals	Mobile Agricul. Machinery	Irrig.	Water Pumping O. Uses	Specific Machines	Lighting	Heat	Transport	TOTAL	Toe/Yr	%
Human	100											100	0.853	1.4
Animal		100										100	0.639	1.0
Fert.Equiv.			100									100	7.345	12.0
Agroch.Eq.				100								100	20.120	32.8
Gas Oil					73.8	22.8	1.7	...		1.5	0.2	100	30.939	50.5
Gasoline					93.8	1.1	2.7	2.4				100	0.830	1.4
Fuel Oil										100		100	0.012	...
Kerosene									6.0	94.0		100	0.079	0.1
LPG									85.3	14.7		100	0.004	...
Firewood										100		100	0.160	0.3
Agricult. Wastes										100		100	0.051	0.1
Wind							100					100	0.017	...
EE.Self Prod.					81.5 (1)			13.6	4.9			100	0.049	...
EE.Public Ut.						2.6	12.1	30.9	54.4			100	0.192	0.4
EE. Total					16.4	2.1	9.7	27.4	44.4			100	0.241	0.4
TOTAL	1.4	1.0	12.0	32.8	38.7	11.5	0.9	0.1	0.2	0.6	0.8	100	61.294	100
Toe/Ton	0.853	0.639	7.345	20.120	23.686	7.053	0.577	0.090	0.115	0.352	0.461	61.294		

(1) Refers to electric power in forestry.

TABLE 8

TOTAL RURAL PRODUCTION SECTOR

Consumption Structure of Useful Energy by Source and Use (1)

Uses / Energy Sources	Human Energy	Animal Energy	Fertil.	Other Agroch.	Mobile Agricul. Machinery	Irrig.	Water Pumping O. Uses	Specific Machines	Light.	Rest	Transport	TOTAL	Kcc/Th	%	Yield by Source
Human	100											100	0.085	0.3	0.10
Animal		100										100	0.121	0.5	0.19
Fert.Equiv.			100									100	4.775	18.7	0.65
Agroch.Eq.				100								100	13.077	51.1	0.65
Gas Oil					76.8	19.8	1.4	...		0.5	1.5	100	7.146	27.9	0.23
Gasoline					93.5	1.0	2.2	3.3				100	0.150	0.6	0.18
Fuel Oil										100		100	0.008	...	0.85
Kerosene									0.2	99.8		100	0.049	0.2	0.61
LPG									16.4	83.6		100	...	...	0.13
Firewood										100		100	0.037	0.1	0.23
Agric.Wastes										100		100	0.007	...	0.13
Wind							100					100	0.003	...	0.18
EE.Self Prod.					85.3 (1)			14.3	0.4			100	0.042	0.2	0.86
EE.Public Ut.						4.2	20.0	65.9	9.9			100	0.082	0.3	0.43
EE. TOTAL					28.8	2.8	13.3	48.4	6.7			100	0.124	0.5	0.51
TOTAL	0.3	0.5	18.7	51.1	22.2	5.5	0.5	0.3	...	0.5	0.3	100	25.582	100	0.417
Kcc/Ton	0.085	0.121	4.775	13.077	5.684	1.413	0.126	0.085	0.008	0.136	0.111	25.582			
Yield by Use	0.10	0.19	0.65	0.65	0.24	0.20	0.22	0.73	0.023	0.98	0.24	0.417			

(1) Refers to electric uses in forestry.

The average energy needed in the rural sector is 61.3 koe/tn at the net or final energy level and 25.6 koe/tn at the useful level.

Consumption structure by use in useful energy shows the importance of the agro-chemical and fertilizer equivalent with almost 70% of the total, as a consequence of the high level of use in citrus and rice cultivation, in spite of being very low in the other activities. From the remainder, mobile agricultural machinery (tractors and harvesters) and irrigation represent 92%.

At the source level, gas oil is outstanding with 93% of the total (outside the energy equivalent of fertilizers and other agrochemicals). Second place is occupied by animate energy (human and animal) with 2.6%, and electricity and gasoline with 2% each rank third. Fuel oil, kerosene, LPG, firewood, wind and agricultural wastes make up the rest.

Average utilization yield is 22.8%, influenced mainly by the agricultural machine yield. If the energy equivalent of fertilizers and other agrochemicals is added a yield of 41.7% can be achieved.

The expectations of the interviewees as regards electricity show that among those who already use it, 70% would apply it to new uses, especially to water pumping, grain drying, workshops and irrigation. Among those who do not use it presently, 87% are interested in its use for irrigation, water pumping and lighting. Among those who replied negatively, 60% reckoned they did not need it and the rest referred to its high price and the high cost of the installations. Infrastructural problems (electricity, roads, workers' housing, etc.) and their high cost were most often mentioned (23% and 22%); in relation to the main difficulties found for the development of their activities, 12% of the replies blamed the low prices of the products sold and the scarcity of labour was also mentioned. Only 12% of the cases did not complain of difficulties.

This information completes the descriptive analysis of the provincial energy system for each of its consumption sectors (except the transport sector) which could be obtained on the basis of the integral processing of the polls carried out.

PART II. ANALYSIS OF THE RELATIONS BETWEEN ENERGY CONSUMPTION AND ITS EXPLANATORY VARIABLES

Introduction

The second part of this report has been aimed at obtaining a series of functional relations between the synthesis of energy variables and different socio-economic variables which would be determinants of energy consumption in each sector. A descriptive analysis of the behaviour of some specific coefficients has also been undertaken. The purpose of these analyses is basically to understand the behaviour of the energy variables in each sector and for each type of activity in the conditions prevailing at the moment of the survey, that means it concerns a cross-section and not a chronological type analysis.

The conclusions and parameters which have been obtained are therefore valid in the short term while their use for forecasting exercises will require some adjustments. The intention of the procedure carried out, even if the information available very often was not as great as would have been desirable, is to indicate a methodology and specific approaches which would contribute to a greater use of the information that can normally be obtained in this kind of survey. The main conclusions drawn from the analyses carried out are presented in the following paragraphs and although the results do not always confirm from a statistical viewpoint the working hypothesis put forward, we consider that this first work on the subject constitutes significant progress with respect to the level of research, in understanding the detailed functioning of the energy system in a specific region of an intermediate developed country.

These results can also be used as a basis for improving the future design of polls and similar questionnaires to be made in other regions. For this purpose it would be interesting to be able to interact with research centres in the regions which have made or are working on similar studies.

Domestic Sector

Relations Between Energy Consumption, Income and Family Size

Starting from the data obtained in the polls, it is possible to relate energy consumption per inhabitant (total electricity and fuels) at net and useful energy levels, with socio-economic type variables, such as income per inhabitant and family size.

For this purpose, two different models were used:

- Model I $E = kI^a$
- Model II $E = kI^a F^b$

where E = energy consumption per inhabitant, I = monetary income per inhabitant, and F = family size.

Both models were adjusted for the urban area, the rural area and the provincial total and in each case data were used for high, medium and low income levels and for the total. This meant that a total of 144 adjustments was made. Data with an error in excess of 200% were eliminated in order to avoid the distortion caused by these values. In this way the adjustment was improved, eliminating less than 10% of the data.

The results obtained with the useful energy values have been significantly more suitable. (See Tables 9 and 10 below.)

From the statistical point of view the results are of good quality ($F > 99\%$), except for high income consumers ($F < 95\%$ in half the adjustments), due to the small amount of data available. In general, quality of the adjustments is higher for electricity than for fuels, for urban area comparison to the rural area, and for useful energy in comparison to net energy.

For the whole of the province, total useful energy consumption elasticityis 0.44 using Model I. The values vary for the different income levels: high: 0.48; medium: 0.61; and low: 0.54, and they are almost always higher in the urban than in the rural areas. In both cases the values for each income level are higher than those of the total population and they grow with the income levels.

The income elasticities for electricity are systematically higher than those for fuels.[1] In the urban area it is close to one (0.96) for the total population, and decreases heavily from the low (1.41) to the high income levels (0.56), showing the saturation process in equipment use and in

[1]Income (price) elasticities of fuel consumption are defined as the ratio of the percentage of change in fuel consumption to the percentage of change in income (price).

TABLE 9

Income-Elasticity of Domestic Consumption

USEFUL ENERGY

Urban Area			
Income Level	Electricity	Fuels	Total
A	0.56	0.17*	0.38*
M	0.67	0.72	0.72
B	1.41	0.46	0.64
T	0.96	0.35	0.50
Rural Area			
Income Level	Electricity	Fuels	Total
A	0.75	0.61	0.65
M	0.63	0.49	0.55
B	0.40	0.37	0.41
T	0.53	0.28	0.35
Total Province			
Income Level	Electricity	Fuels	Total
A	0.76	0.27*	0.48
M	0.74	0.52	0.61
B	1.50	0.38	0.54
T	1.04	0.29	0.44

*/ - Non-significant values at the 5% level, according to coefficient F.

TABLE 10

Income ( ) and Family Size (β) Elasticity for Domestic Consumption

USEFUL ENERGY

Urban Area	Electricity		Fuels		Total	
	α	β	α	β	α	β
A	0.63*	0.14*	-0.21*	-0.72*	0.24*	-0.27*
M	0.27	-0.79	0.38	-0.60	0.68	0.01
B	1.54	0.21	0.23	-0.49	0.44	-0.44
T	0.91	-0.24	0.21	-0.59	0.40	-0.45
Rural Area						
Income Level	Electricity		Fuels		Total	
	α	β	α	β	α	β
A	0.82	0.43	0.71	0.59	0.74	0.52
M	0.27	-0.58	-0.16	-0.92	-0.06	-0.87
B	1.09	1.62	-0.07	-0.99	-0.03	-0.94
T	1.30	0.51	0.06	-0.72	-0.15	-0.65
Total Province						
Income Level	Electricity		Fuels		Total	
	α	β	α	β	α	β
A	0.83	0.13	0.44*	0.44*	0.60	0.33
M	0.67	-0.14	0.005	-0.94	0.25	-0.57
B	1.79	0.81	0.07	-0.65	0.25	-0.62
T	1.05	0.13	0.13	-0.62	0.30	-0.52

*/ - Non-significant values at the 5% level, according to coefficient F.

use intensity with no restriction on the supply side. In the rural area, by contrast, the total elasticity is lower (0.53) and it increases from the low income level (0.40) to the high (0.75). This tendency shows supply restriction and a low capacity to invest in electric appliances at the low income level; for the medium income level elasticities are similar and for the high income level in the rural area they are higher than those for the urban area, possibly because saturation in stock appliances is lower there. Taking the whole province income elasticity is 1.04 and it decreases from 1.5 for the low to only 0.75 for medium and high income.

In the case of fuel consumption, elasticity is only 0.29 for the whole province, being higher in the urban (0.35) than in the rural area (0.28), and it increases with the income levels showing a different trend from that of electricity. For the rural area by contrast, behaviour is similar to that of electricity with values increasing from 0.37 at the low level to 0.61 at the high. In the urban area all the values are higher than those of the rural area (except for the high level which is not significant from the statistical viewpoint) and also increases with income. All these trends can be explained by the fact that fuel uses are close to saturation, especially in the case of cooking, although this is not quite the case but less for water and space heating at the medium and high income levels. The different elasticities for fuels and electricity show a sustained penetration of the latter, both for substituting for fuels and for satisfying new uses.

The indicated values have been obtained by cross section and thus it could be said that "short-term" elasticities are involved. This type of analysis has the advantage of ensuring the constancy of other variables which influence energy consumption, but it does not allow price elasticity to be calculated.

An attempt was made using Model II to identify the influence of family size on useful energy consumption. As was to be expected, the analysis confirmed the consumption of economies of scale since negative elasticities were obtained in the majority of cases, particularly for fuels at the low and medium income levels and for electricity at the medium and high ones.

For total consumption in the whole province, elasticity with respect to family size is -0.52. This means that if family size increases four times, the per capita consumption would be reduced to half. At the same time the income elasticity is reduced to 0.30. We can explain this by saying that in Model I the higher per capita consumptions are not directly caused by an increase in income, but rather the decrease in family size. This implies that the influence of income growth produces greater consumption, more through the indirect than the direct effect on family size.

For the different income levels, values of a and b are obtained which are quite similar to those of the total except for the high income level which has values that are not statistically representative.

For the total urban area, the values are: a = 0.40 and b = -0.45, quite similar to the total. On the other hand, there is a negative income elasticity for the rural area (a = -0.25) and b higher, in absolute values, than that of the urban area (b = -0.65).

If the different income levels are considered independently, zero or negative income elasticities are obtained in the rural area, while for the urban area all are positive. Family size elasticities are almost always negative or zero except for the high income level in the rural area. As regards the differences existing between electricity and fuels, it can be said that for the former the values of both a and b are positive in the majority of cases, while for the latter the values of b continue to be negative and those of a become positive in many cases, although with very low values. That would seem to indicate that in the case of fuels there are strong scale economies, which are quite evident for the case of cooking and to a lesser degree in space and water heating. Conversely, for electric uses in the low income levels, the family size would appear to produce the incorporation of new appliances or a more intensive use of the existing ones.

Penetration of Uses and Appliances with Family Income

To calculate an approximate value of the income elasticity of penetration of the different uses and appliances, the percentage increases of penetration between the three income levels studied and the corresponding percentage increases of the average income in each level were correlated.

For uses in the urban area, elasticity for lighting, cooking, water heating, (from medium to high income) and other appliances is zero since penetration is complete. This does not mean that the quality or intensity with which these uses are satisfied is not modified with income, as we should see later. For all other domestic uses, elasticity is low (less than 0.32) in the low-medium income range and practically zero (less than 0.1) in the medium-high income range, which reflects the high degree of penetration reached starting with the medium incomes. By contrast, the values corresponding to individual transport are considerably higher, 1.125 in the low-medium income range and 0.317 in the medium-high income range.

In the rural area elasticity is zero is four uses: lighting, cooking, water supply and water heating because penetration is total. For the remaining uses the elasticities in the low-medium income range are greater than in the urban area, increasing from food preservation (0.10) to space cooling (0.56). In general, the elasticity increases while initial use penetration is lower. In the medium-high income range where a significant modification in the average income is found (+214%), the elasticities are very low (less than 0.09) in all uses, although the intensity of the use could be increased and quality of service improved. In this case also the electricity for individual mechanical transport is very high; 2.1 in the low-medium income range and 0.28 in the medium-high income range.

If the penetration elasticity of each of the domestic appliances is analyzed, a wide variety of values is obtained which vary between ±2.0 (except for the cases where it is ±00). In any movement from the first to the second range, a sharp drop in income elasticity is observed, which indicates that already in the medium levels saturation point was very close. In various cases there is an inversion of elasticity from positive to negative, which would mean that these appliances are subsituted by others with better quality or yield, since the use they satisfy continues to increase its penetration or the quality and level of satisfaction.

The appliances with a negative elasticity in the first range normally maintain it in the second which would be meaning that they are in the process of being abandoned as income level rises.

If the appliances are set out according to the decreasing order of their elasticity in both ranges and both for the urban and rural areas, they can be grouped into seven categories. Those which have high positive elasticities (>1.0), medium (>0.30) and low (>0.1); those which are inelastic and those which have low negative elasticities (<-0.1),medium (<-0.3) or high (<-1.0). For the low-medium income range the appliances which are inelastic to income are found to be those which have already reached saturation at the first level; those with positive values are the ones which are more modern or of better quality and are beginning to penetrate the market, and are connected basically with the use of LPG and electricity. Conversely, those with negative values are mostly appliances that are becoming obsolete and are connected basically with kerosene, firewood and charcoal.

A similar, though more accentuated situation is observed at the medium-high income range. The number of appliances with positive elasticities is markedly reduced while the number of inelastic

ones and with negative inelasticities is increased. In general, there is a drop of elasticity in all cases compared with the previous range.

The appliances with elasticities close to zero are those which have already reached saturation level in the market in the medium income level. Naturally there are particular situations both in the urban and the rural area; these shall not be dealt with in detail here, as they are explained in the main report.[2]

Using the penetration of uses and the average income of the three levels, it is feasible to estimate an average elasticity for the whole income range on the basis of the Model $P = P_0 I^a$ (where P_0 = penetration when I = 1 and I = income). This model was applied to 10 appliances with the most penetration in the urban and rural areas.

In the first case, values of a are obtained which, in general, increase to the extent that the general penetration level of the appliance decreases; with the exception of the radio which has a negative elasticity, and the fan which modifies its tendency from one range to the other. The first four appliances (LPG cooker, incandescent lamp, iron and electric refrigerator) demonstrate very low elasticity (0.05 to 0.12) and their degree of penetration is over 90%. For the following four (television, washing machine, record player and grill), elasticities are intermediate (0.25 to 0.47) and their degree of penetration varies between 48% and 85%. In the rural area also elasticities increase to the extent that penetration decreases, and there is less variation than in the urban area with higher values for the first appliances (incandescent lamp, radio, LPG cooker, iron, electric refrigerator and fan) which vary between 0.1 and 0.2 and with slightly lower values of about 0.31 for the remainder (television, washing machine). In general, penetration of uses is below that of the urban area.

Descriptive Analysis of Total Energy Consumption per Inhabitant

Starting with the 370 polls in the urban and rural areas, total consumption per inhabitant was calculated for net and useful energy and the distribution frequency for each area and income level was analyzed in order to detect the corresponding distribution functions. For each distribution of frequencies the average, the mode, the median, the coefficient of variability, of asymmetry and of kurtosis were calculated. (See Tables 11 and 12.)

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[2]A Regional Energy System, the Entre Ríos Province (Argentina), Report No. 2, IDEE, December 1982.

TABLE 11

DESCRIPTIVE ANALYSIS OF THE DOMESTIC NET ENERGY CONSUMPTION PER INHABITANT (Koe/h)

AREAS: URBAN & RURAL

INCOME LEVEL: LOW, MEDIUM, HIGH

Characteristics / Sectors	N	$\bar{x}$	Mode	Median	Range	σ	Coefficient Variation	Asymmetry	Kurtosis
Urban Low	118	128,05	108,53	114,89	316,00	65,87	51,44	1,39	4,59
Urban Medium	72	144,31	90,00	113,63	514,17	101,01	70,00	2,04	7,34
Urban High	19	175,00	140,00	165,00	267,37	72,07	41,18	0,62	2,44
Urban Total	209	137,92	103,51	118,33	514,17	81,04	58,76	1,91	7,81
Rural Low	77	249,11	163,33	183,82	1051,33	203,42	81,66	2,09	8,10
Rural Medium	72	214,37	125,00	163,63	749,50	153,91	71,80	1,93	6,88
Rural High	12	241,95	150,00	175,00	450,40	138,78	57,36	0,92	2,69
Rural Total	161	233,04	133,33	178,22	1051,33	178,27	76,50	2,14	8,71
U + R TOTAL	370	179,31	124,87	136,73	1058,17	140,40	78,30	2,76	13,74

TABLE 12

DESCRIPTIVE ANALYSIS OF THE DOMESTIC USEFUL ENERGY CONSUMPTION PER INHABITANT (Koe/h)

AREAS: URBAN & RURAL

INCOME LEVEL: LOW, MEDIUM, HIGH

Characteristics / Sectors	N	$\bar{x}$	Mode	Median	Range	σ	Coeff. Variation	Asymmetry	Kurtosis
Urban Low	119	48,84	40,56	43,63	198,39	30,48	62,41	2,16	9,95
Urban Medium	72	61,30	40,63	47,14	201,93	40,00	65,25	1,94	6,78
Urban High	19	78,12	67,50	72,50	91,6	28,37	36,32	0,28	1,78
Urban Total	210	55,76	41,04	46,51	203,24	34,94	62,66	1,91	7,68
Rural Low	77	49,98	40,56	44,93	131,18	27,39	54,80	1,46	5,30
Rural Medium	72	54,97	41,67	47,30	138,27	26,80	48,75	1,60	5,65
Rural High	12	75,31	57,14	58,33	261,37	71,47	94,90	2,47	7,85
Rural Total	161	54,10	41,84	46,95	281,82	32,69	60,43	3,20	21,46
U + R TOTAL	370	55,04	41,42	46,71	289,39	33,95	61,68	2,45	12,84

By taking the set of data for the net energy in the urban area, including the three income levels, a distribution of frequencies is obtained whose average value is 137.9 koe/inhabitant, a variability coefficient of 58.8 and positive asymmetry and kurtosis values. (See Figure 7.)

At the different income levels the distributions of the medium and low levels are very similar, with the aspect of a normal distribution, but a certain asymmetry appears which increases the frequency of the lower than average values and shows greater dispersion in the higher consumptions. Distribution of the high level is closer to normal and is displaced somewhat towards the highest consumption (see Figure 8). In the rural area the total values give a distribution frequency whose average value is 233 koe/inhabitant (69% higher than in the urban area); the variability coefficient is 76.5 and it has positive asymmetry and kurtosis values (see Figure 9). It was found that distribution at the low and medium income levels are very similar while a certain differentiation for the high level is detected. The differences are much more noticeable than those for the urban area (see Figure 10).

In comparing the distributions for the rural and urban areas it is seen that the average consumption is higher for the former due to the lower yields. A greater dispersion of consumptions and higher values of asymmetry and kurtosis are also evident (see Figure 11). Distribution for the whole province give an average consumption of 179.3 koe/inhabitant with a dispersion coefficient of 78.3, the asymmetry and kurtosis coefficients being positive (see Figure 12).

Transformation into useful energy in both areas leads to an improvement in the distribution polygons and to a normalization of behaviour of the position measures in relation to income evolutions. Average consumption grows significantly with income and, in addition, a significant improvement is seen in the variability coefficient, maintaining their positive values, asymmetry and kurtosis coefficients (see Figures 13 and 14).

The distribution for the total urban area has an average value of 55.8 koe/inhabitant, a variability coefficient of 62.7 and positive values of asymmetry and kurtosis (see Figure 15). It was found that the distribution for the low and medium income levels are very similar. By contrast, the distribution for the high level is clearly displaced towards the right (higher consumption) and with very low coefficients of variability, asymmetry and kurtosis, which bring it close to a normal distribution.

FIGURE 7

NET ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

URBAN DOMESTIC SECTOR TOTAL

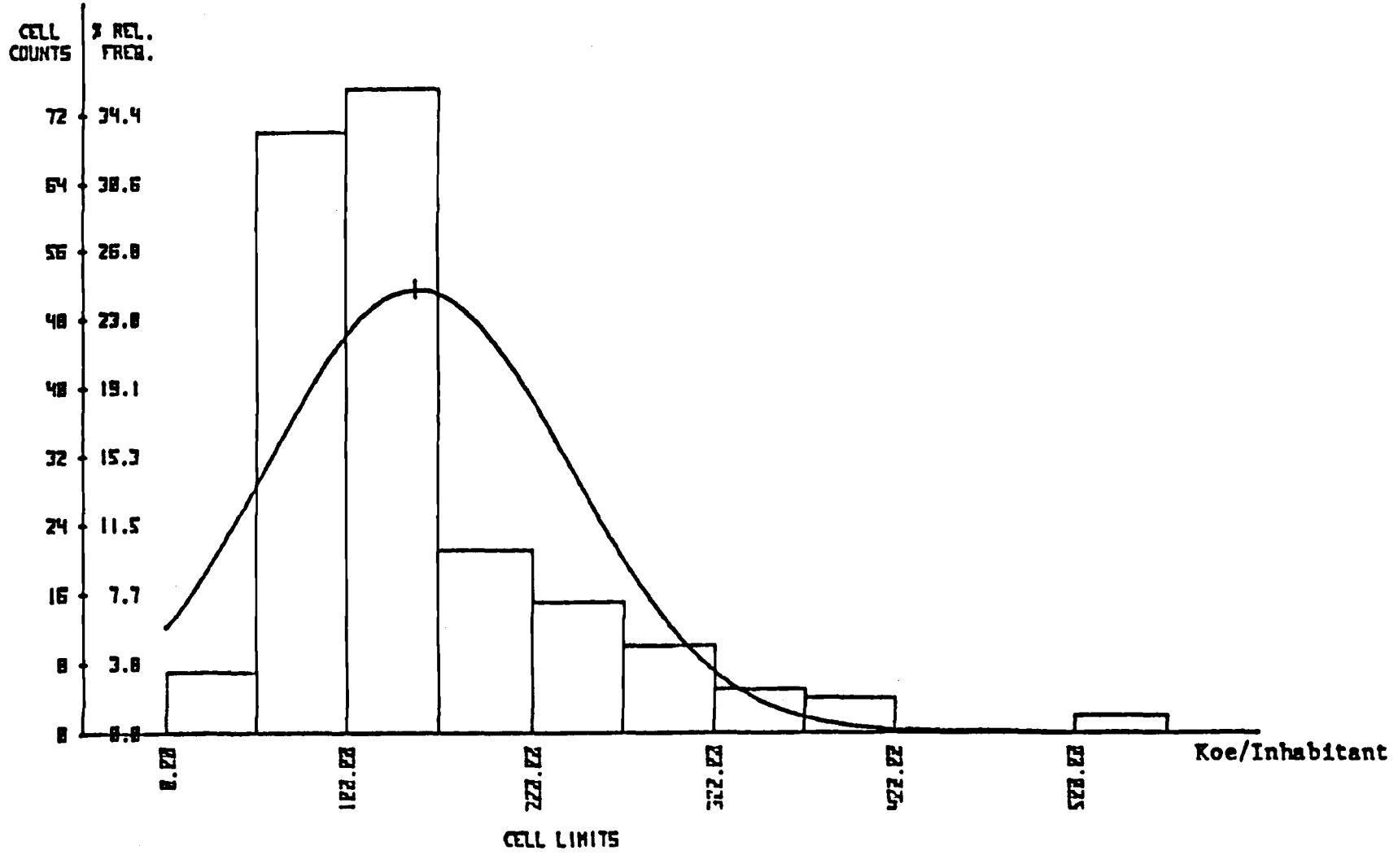


FIGURE 8

NET ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

URBAN DOMESTIC SECTOR BY INCOME LEVEL

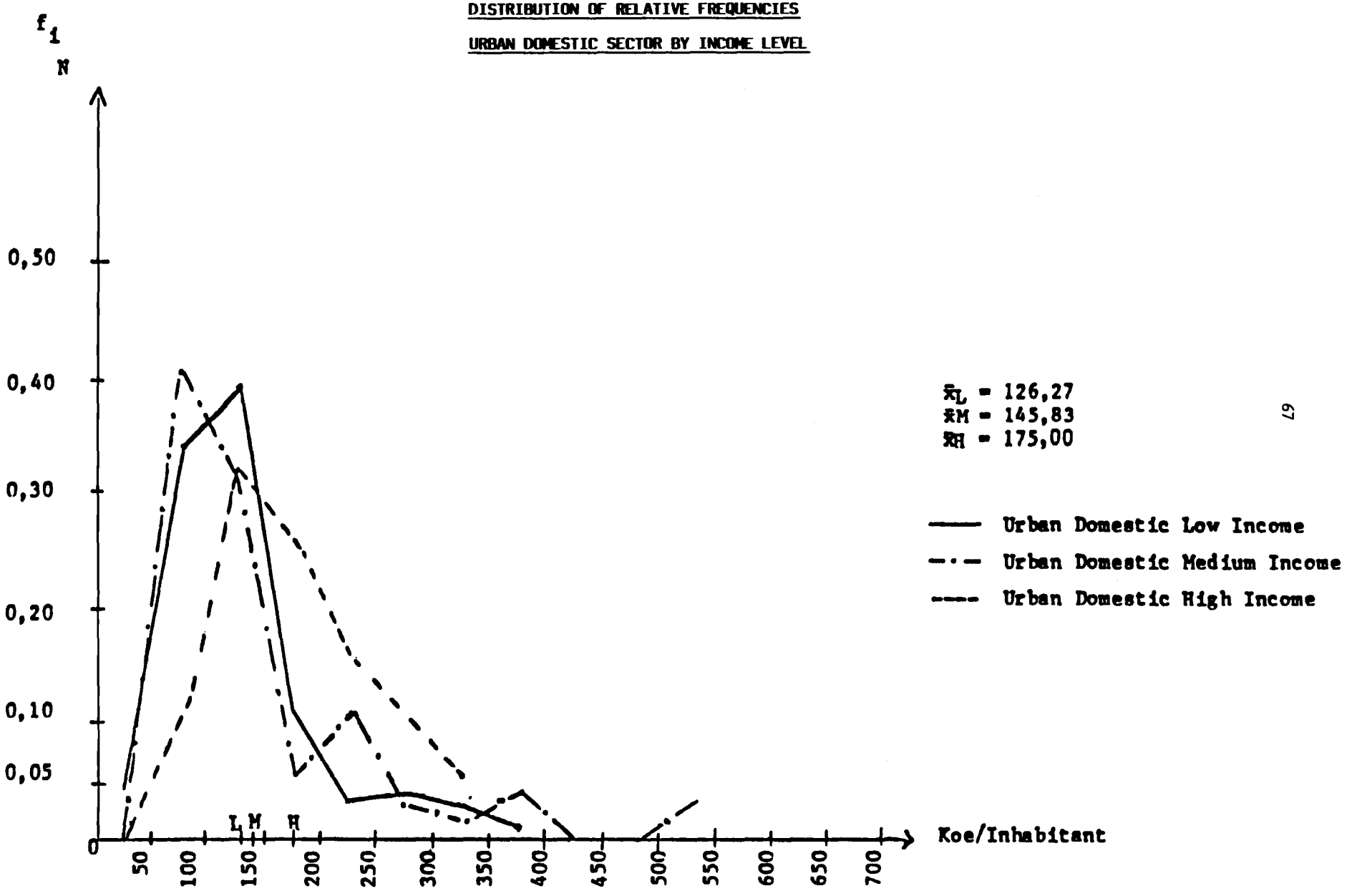


FIGURE 9

NET ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

RURAL DOMESTIC SECTOR TOTAL

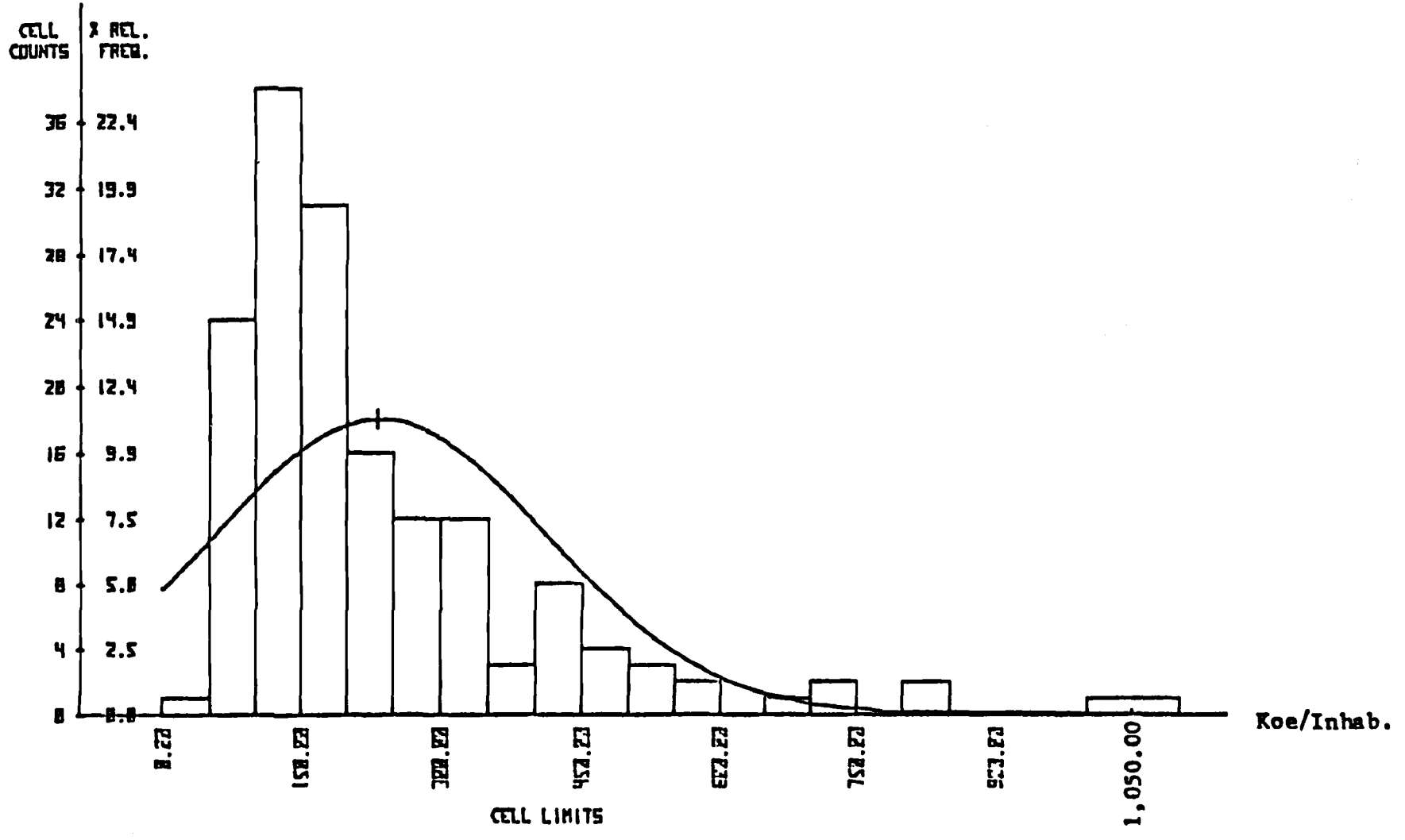


FIGURE 10

NET ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

RURAL DOMESTIC SECTOR BY INCOME LEVEL

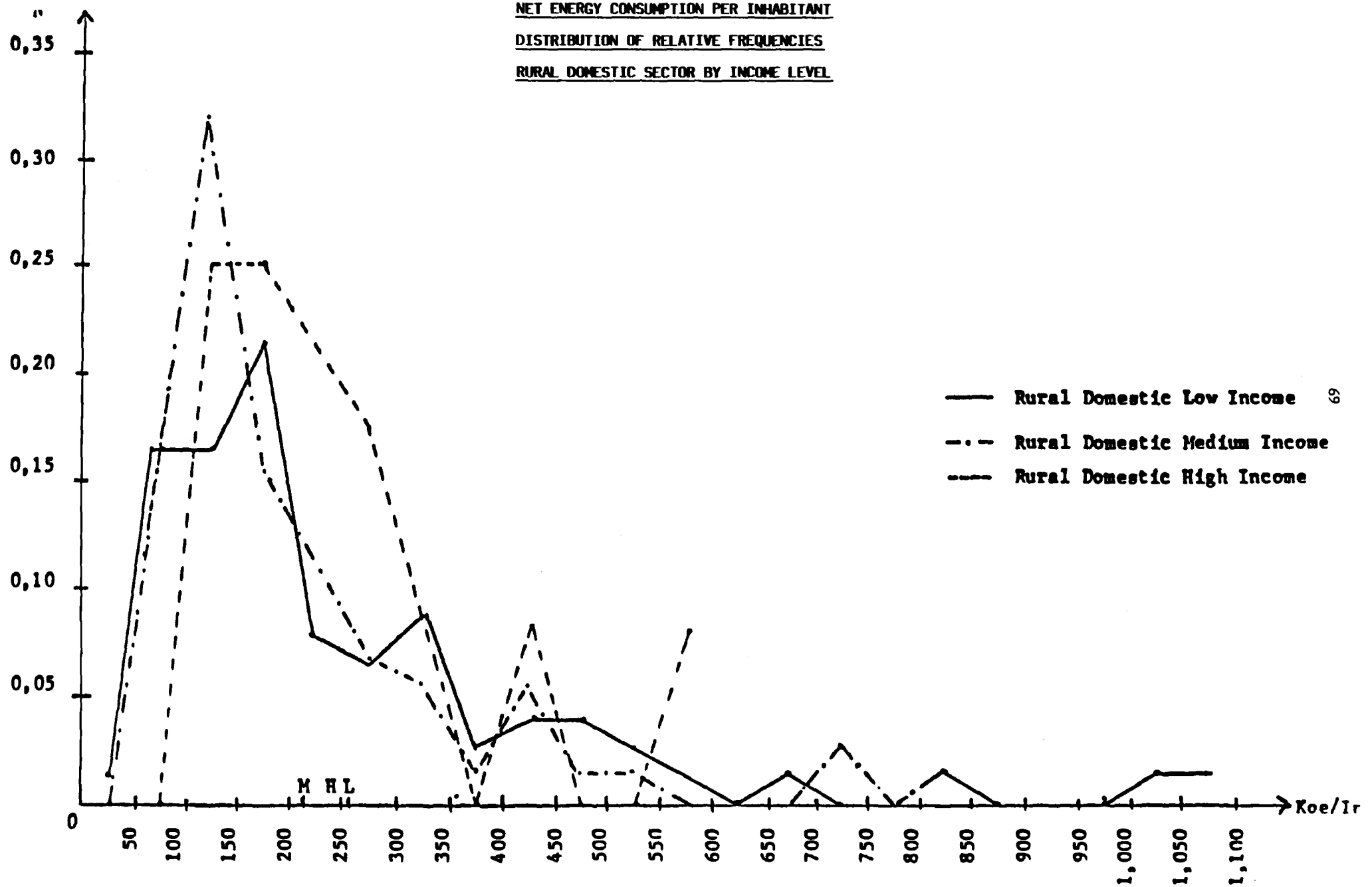


FIGURE 11

NET ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

DOMESTIC SECTOR

RURAL & URBAN AREAS AND TOTAL

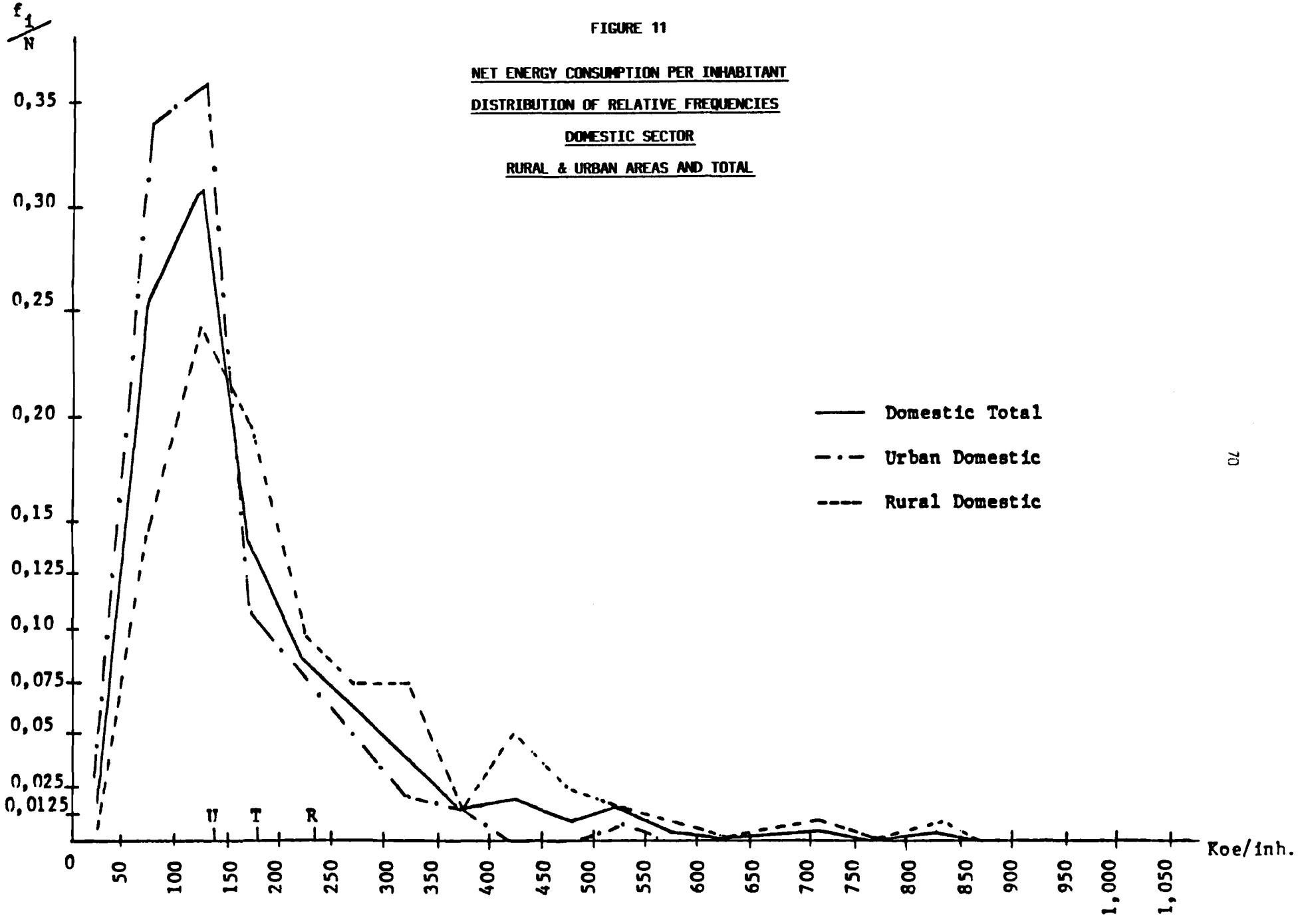


FIGURE 12

NET ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

DOMESTIC SECTOR, PROVINCIAL TOTAL

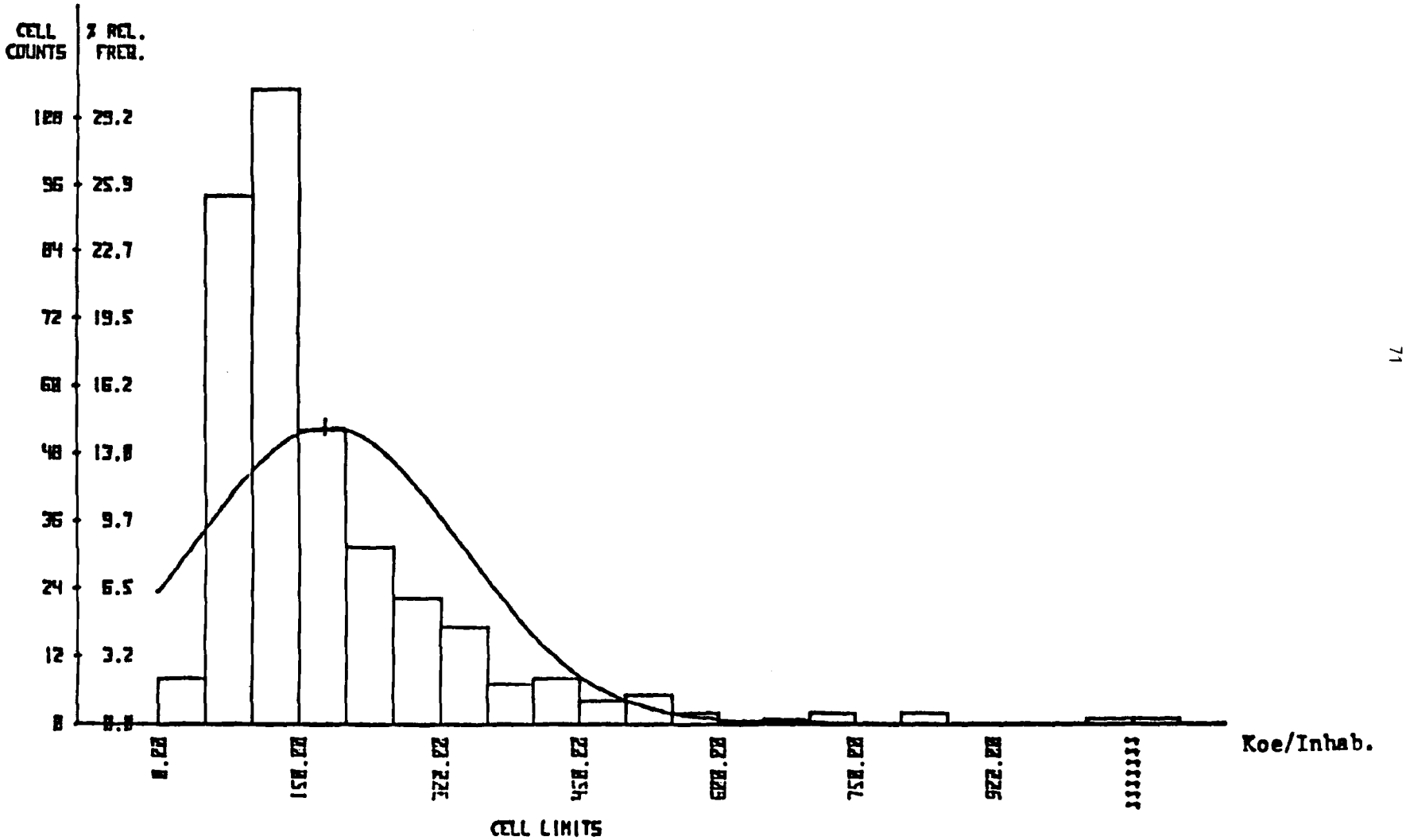


FIGURE 13

USEFUL ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

URBAN DOMESTIC SECTOR BY INCOME LEVEL

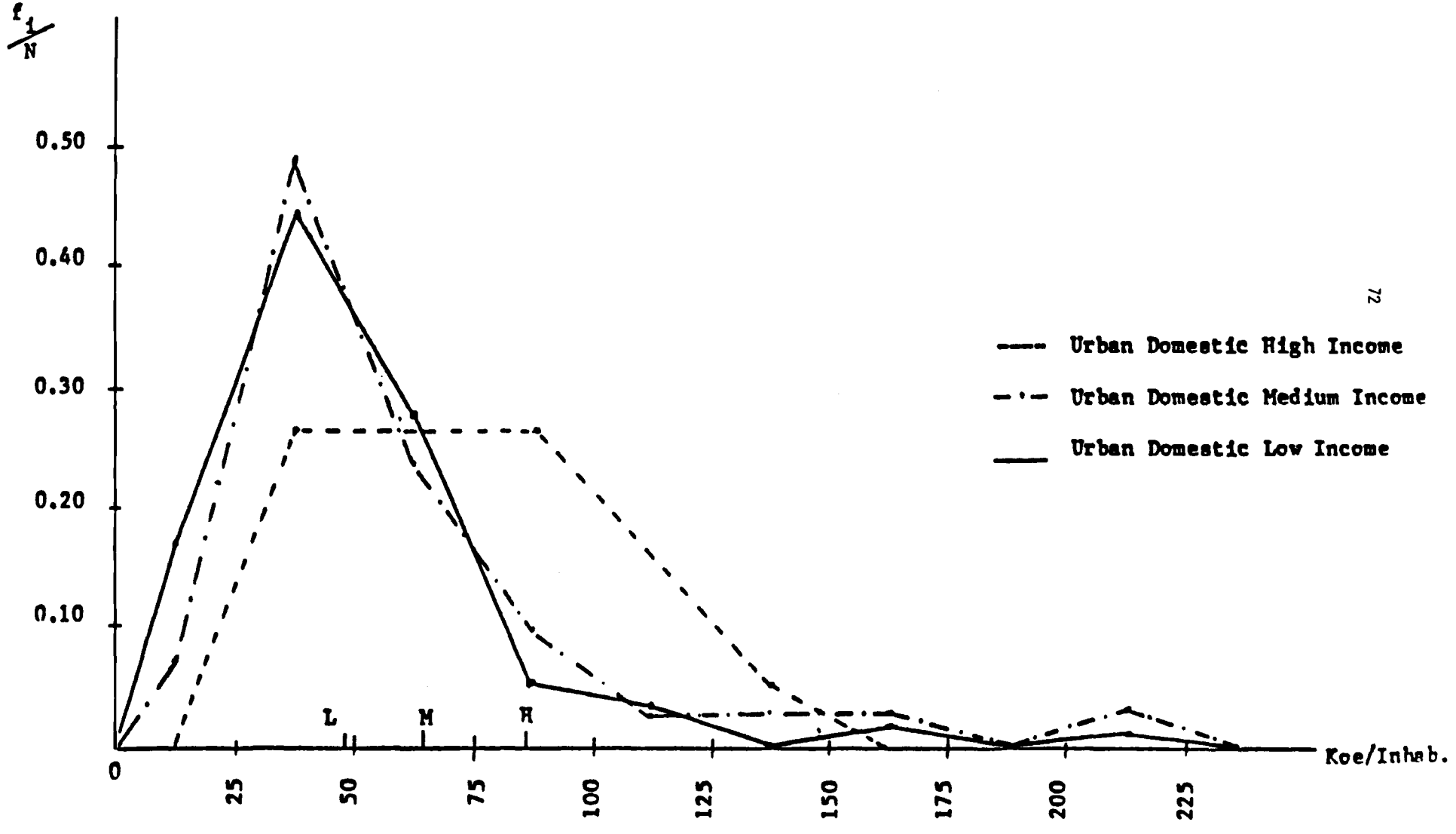


FIGURE 14

USEFUL ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

RURAL DOMESTIC SECTOR BY INCOME LEVEL

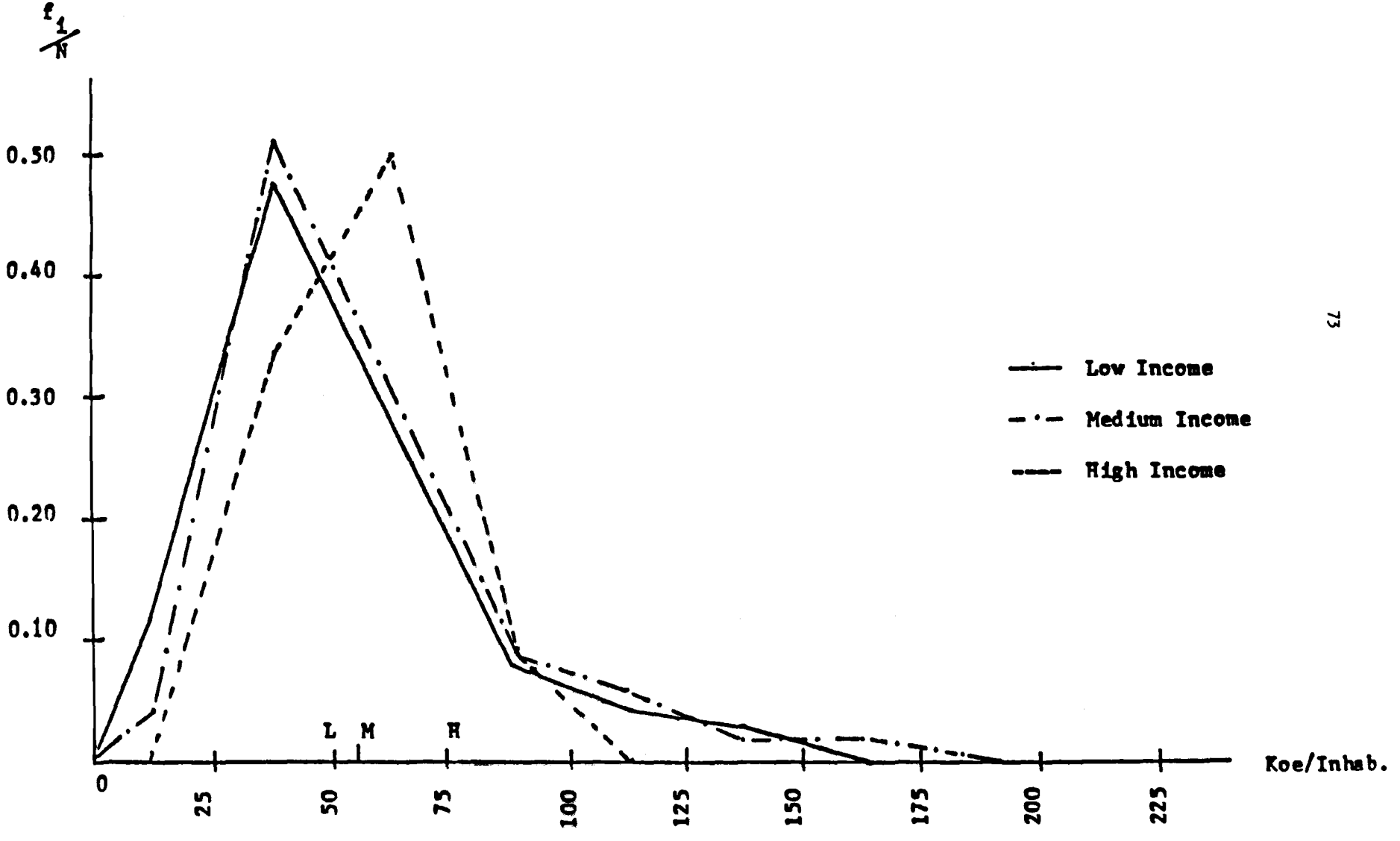
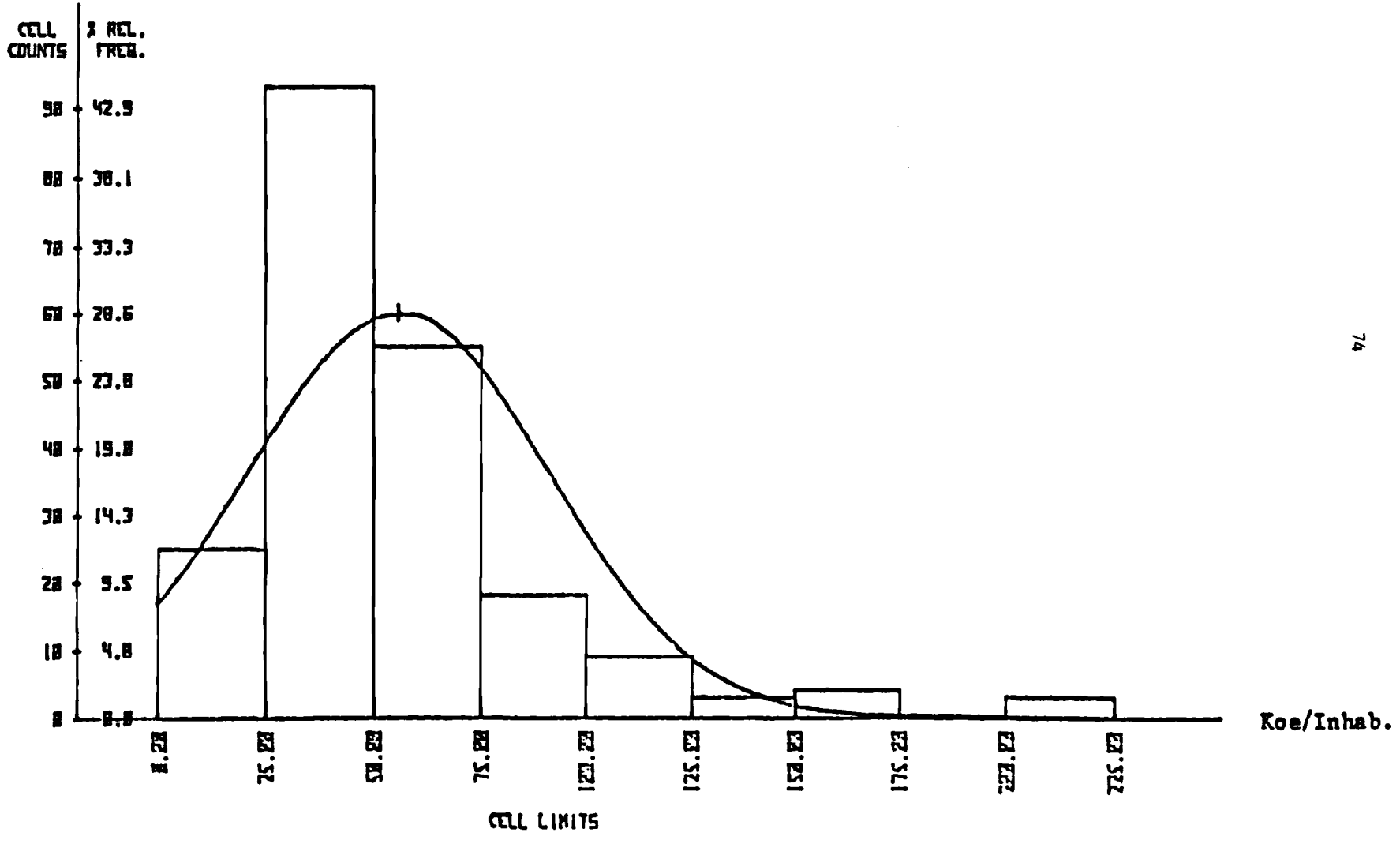


FIGURE 15

USEFUL ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

DOMESTIC SECTOR URBAN TOTAL



For the rural area, the distribution has an average value of 54.1 koe/inhabitant, a dispersion of 60.4 and positive values of asymmetry and kurtosis coefficients. The situation of the distribution for the different income levels is similar to the urban area (see Figure 16).

Finally, for the provincial level, average consumption is 55 koe/inhabitant, the most frequent values are those between 25 and 50 koe/inhabitant, although consumptions greater than 100 koe/inhabitant do appear in nearly 10% of the cases (see Figure 17).

Rural Production Sector

Overall Relations

The variables analyzed are human work, mechanical work, area of the establishments and the production of agrarian goods.

Regression analysis is made using the following models:

(1) $Ce = K_1 H^{\alpha 1} M^{\beta 1} T^{\gamma 1} P^{\delta 1}$

(2) $Ce = K_x T^{\gamma 2} P^{\delta 2}$

(3) $Ce = K_3 P^{\delta 3}$

(4) $Ce = K_4 H^{\alpha 4} M^{\beta 4} P^{\delta 4}$

Where:

Ce = net or useful energy consumption (Koe)

H = man-hours worked (10^3 m-h)

M = HP-hours of machinery used (10^3 HP hours)

T = area of establishments (Hectares)

R = tons of product obtained (Tn)

The first two models are applied to each of the following activities: cattle-raising, agriculture (except rice fields and vegetable gardens), dairies, rice fields, vegetable gardens, and citrus plantations, as well as the whole group of them. Model 3 is used for the production of eggs and poultry, as well as for grain drying. Model 4 is used for the total of the sector. Tables 13 to 15 include the values of the parameters and of the main statistics for each of the models.

FIGURE 16

USEFUL ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

RURAL DOMESTIC SECTOR TOTAL

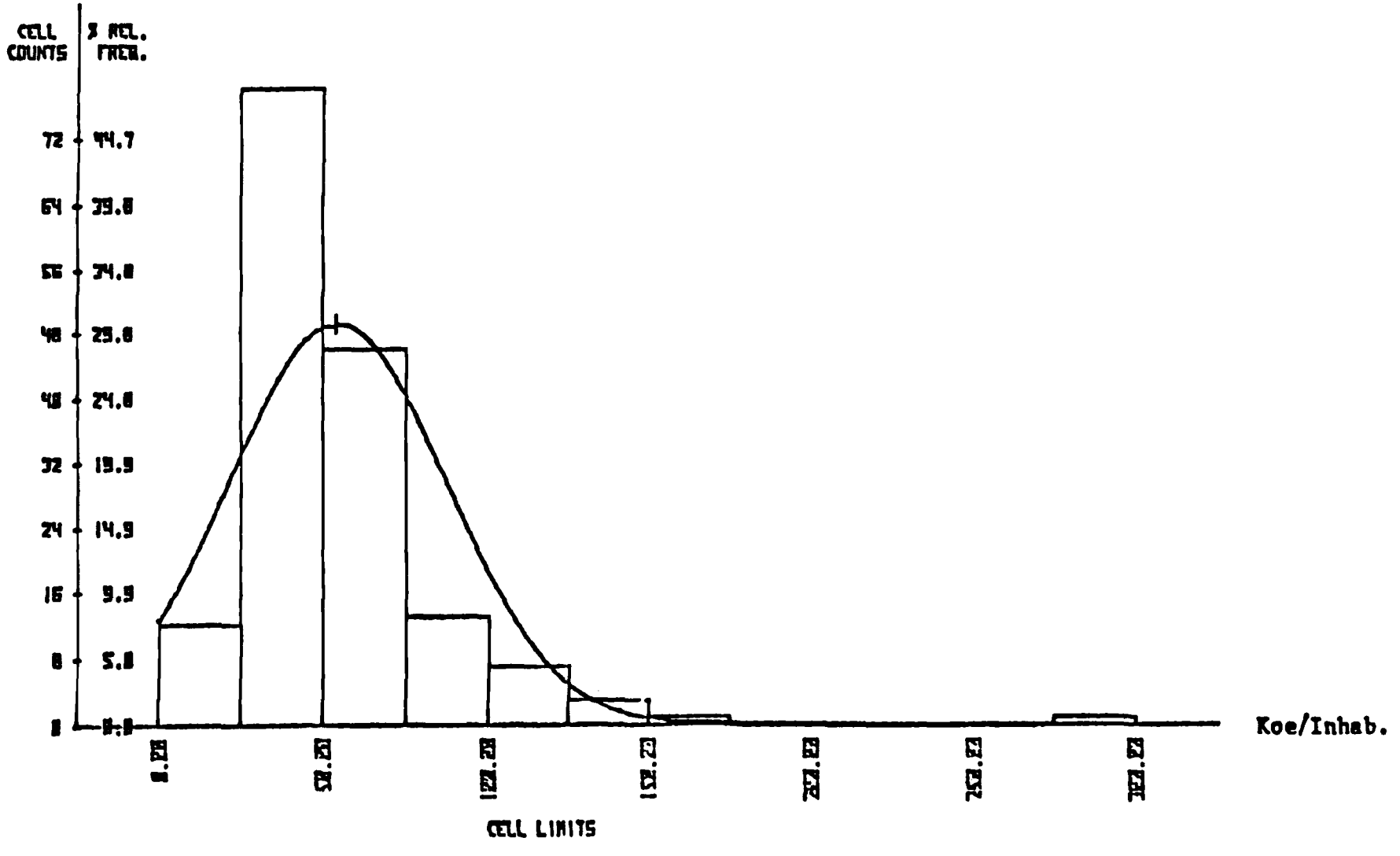


FIGURE 17

USEFUL ENERGY CONSUMPTION PER INHABITANT

DISTRIBUTION OF RELATIVE FREQUENCIES

DOMESTIC SECTOR, PROVINCIAL TOTAL

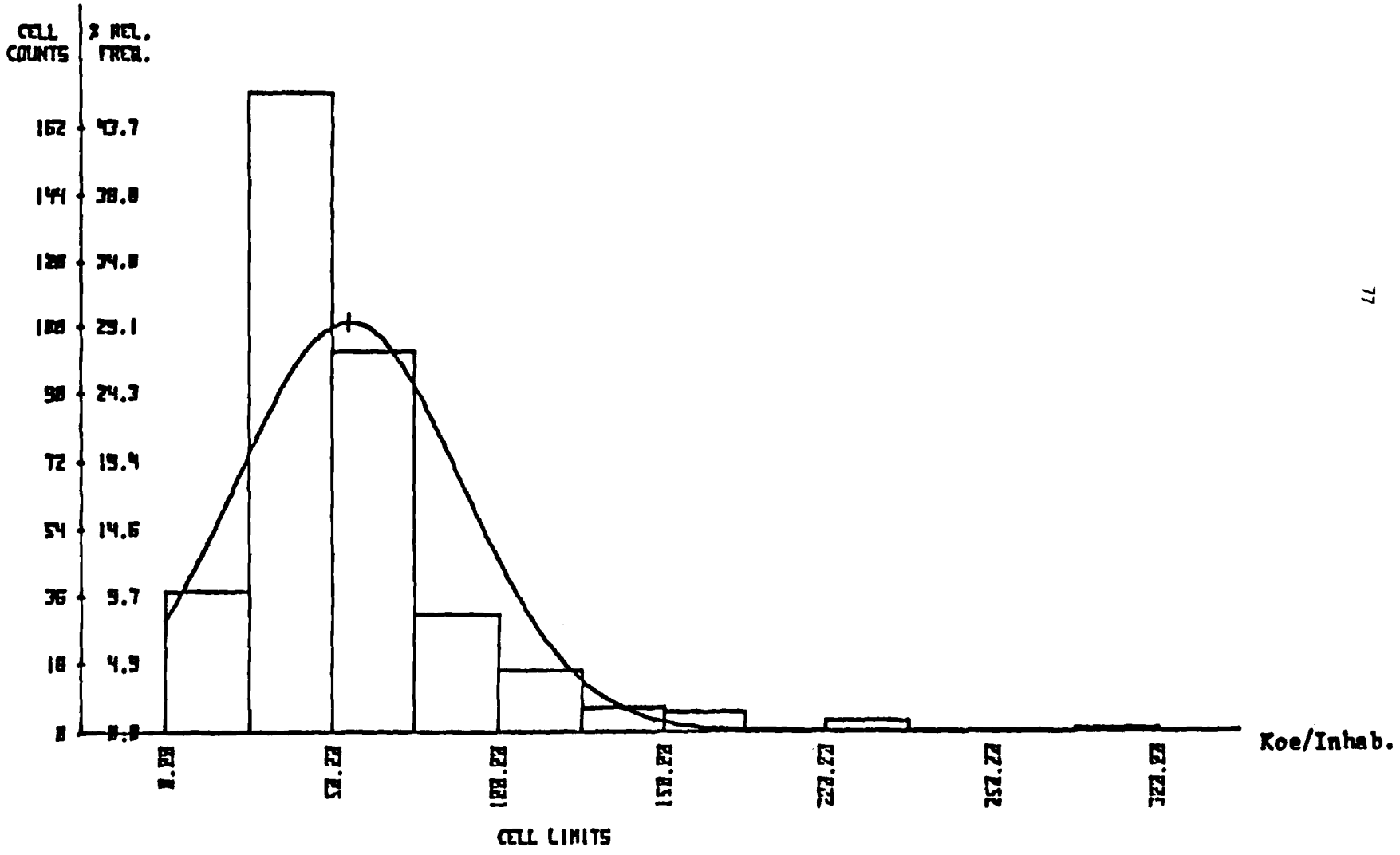


TABLE 13

PARAMETERS VALUES AND MAIN STATISTICAL FOR MODEL: $Ce = K_1 H^{\alpha_1} . M^{\beta_1} . T^{\gamma_1} . P^{\delta_1}$

Activity	Energy	Number of Data	K_1	α_1	β_1	γ_1	δ_1	Correlation Coefficients /H	/M	/T	/P	Multiple Correlation
Cattle Raising	Net	8	21,98	-0,013	0,55	0,94	-0,31	0,83	0,96	0,96	0,90	0,997
	Useful	8	1,75	-0,16	0,84	1,47	-0,98	0,69	0,91	0,85	0,75	0,96
Agriculture	Net	12	162,38	0,09	0,29	0,34	0,29	0,76	0,96	0,94	0,95	0,99
	Useful	12	31,82	0,01	0,36	0,38	0,24	0,75	0,97	0,93	0,95	0,99
Dairies	Net	8	16.647,2	0,27	0,48	0,001	-0,62	0,32	0,92	0,91	0,59	0,95
	Useful	8	4.272,7	0,27	0,51	0,05	-0,73	0,33	0,93	0,93	0,58	0,97
Rice Cultivation	Net	6	206,44	0,41	1,10	0,24	-0,51	0,80	0,98	0,84	0,9	0,99
	Useful	6	42,95	0,09	0,86	0,10	-0,03	0,79	0,99	0,82	0,93	0,99
Vegetable Gardens	Net	6	179,47	0,03	0,66	0,19	0,11	0,25	0,96	0,46	0,64	0,99
	Useful	6	37,34	-0,16	0,90	0,11	0,04	0,13	0,98	0,40	0,52	0,99
Citric Fruit Farming	Net	22	409,12	0,23	0,46	0,26	0,06	0,90	0,97	0,96	0,91	0,99
	Useful	22	186,79	0,33	0,29	0,40	0,03	0,91	0,94	0,95	0,90	0,97
Sub Total	Net	62	208,51	0,18	0,34	0,22	0,30	0,74	0,92	0,74	0,89	0,98
	Useful	62	59,15	0,29	0,41	0,09	0,29	0,77	0,91	0,66	0,89	0,97

TABLE 14

PARAMETERS VALUES AND MAIN STATISTICALS FOR MODEL: $Ce = k_2 T^{\gamma_2} P^{\rho_2}$

Activity	Energy	Number of Data	k_2	γ_2	ρ_2	Coefficients Correlation /T	Coefficients Correlation /P	Multiple Correlation
Cattle Raising	Net	8	9,116	1,32	-0,16	0,96	0,90	0,96
	Useful	8	0,502	1,99	-0,76	0,85	0,75	0,88
Agricultural	Net	12	22,19	0,37	0,92	0,94	0,95	0,95
	Useful	12	3,00	0,31	1,1	0,93	0,95	0,95
Dairies	Net	8	151,41	0,96	-0,15	0,91	0,59	0,91
	Useful	8	29,66	1,06	-0,23	0,93	0,58	0,93
Rice Cultivation	Net	6	145,47	0,50	0,58	0,84	0,90	0,95
	Useful	6	62,18	0,37	0,60	0,82	0,93	0,97
Vegetable Gardens	Net	6	387,61	0,47	0,26	0,46	0,64	0,70
	Useful	6	85,63	0,50	0,24	0,40	0,52	0,58
Citric Fruit Farming	Net	22	232,76	0,80	0,29	0,96	0,91	0,97
	Useful	22	88,23	0,80	0,30	0,95	0,90	0,96
Sub Total Without Forestry	Net	62	65,36	0,42	0,68	0,74	0,89	0,94
	Useful	62	13,74	0,33	0,81	0,66	0,89	0,91
Sub Total with Forestry	Net	64	79,04	0,44	0,63	0,74	0,87	0,92
	Useful	64	17,12	0,35	0,74	0,66	0,87	0,89

TABLE 15

PARAMETERS VALUES AND PRINCIPAL STATISTICS

A. Model: $Ce = K_3 \; P^{\beta_3}$

Activity	Energy	Number of Data	K_3	β_3	Coefficient Correlation
Egg Production	Net Useful	4 4	64,07 12,42	0,75 0,76	0,69 0,63
Poultry Meat	Net Useful	4 4	651,97 361,41	0,38 0,33	0,41 0,24
Grain Dryers	Net Useful	4 4	780,55 0,0006	0,36 2,57	0,13 0,79

B. Model: $Ce = K_4 \; H^{\alpha_4} \; M^{\beta_4} \; P^{\beta_4}$

Activity	Energy	Number of Data	K_4	α_4	β_4	β_4	Coeff.Correlation /H	/M	/P	Multiple Correlation
TOTAL SECTOR	Net Useful	76 76	393,47 82,27	0,087 0,194	0,421 0,433	0,346 0,338	0,72 0,74	0,91 0,90	0,84 0,84	0,96 0,95

In general, the regressions are acceptable for models 1, 2 and 4 from the point of view of the partial correlation coefficients, the multiple correlation coefficient and the T and F statistics. With regard to model 3 the T and F tests would recommend rejecting the explanation of energy consumption in function of amount produced (eggs or poultry meat) or of grain dried.

In the models where the amount of HP-hours of machinery used appears as a variable, this explains the energy consumed to the greatest extent. This is a logical comment in view of the high degree of relative mechanization of the activity in the province.

The excellent adjustment of model 2 is interesting, linking the energy with the land resource and the amount of goods produced.

In general, the adjustments are similar for net or useful energy and in both cases are very close to a multiple correlation coefficient of 0.95.

Input-Output Relations

The rural production sector has been divided into ten activities: agriculture, cattle-raising, rice cultivation, vegetable gardens, dairies, citrus fruit farming, forestry, egg production, poultry meat production and grain drying.

For each of these activities, relations have been established between the different production inputs, energy consumption (total and by uses), total installed power and the value of the production sold with the area occupied by the establishments and/or the production obtained.

The production inputs analyzed are: labour, animal power, fertilizers, other agrochemicals, mobile agricultural machinery, irrigation, water pumping and specific stationary machinery. In Table 16 the different relations established for each activity are shown. The figures speak for themselves and in the main report there is a more detailed analysis.

TABLE 16

RELATIONS BETWEEN INPUTS AND PRODUCTION FACTORS

RURAL PRODUCTION SECTOR

	Labor		Animal Energy		Agricultural Machinery		Fertilizers		Agrochemicals	
	hs/M / He	hs-M / Tn	hs-A / He	hs-A / Tn	HP-hs / Ha	HP-hs / Tn	Kgrs / He	Kgrs / Tn	Kgrs / He	Kgrs / Tn
Agricultural	14,5	30,2	0,080	0,166	902,3	1882	0	0	0,146	0,30
Cattle Raising	9,54	27	16,76	48	124,4	354	11,8	32,1	0,36	1,03
Rice Cultivation	43,88	13,26	0	0	1583	478	27,4	8,27	6,3	1,90
Vegetable Gardens	593,8	73,5	327	40,4	3267	425,4	4,2	0,55	1,29	0,17
Dairies	34,5	53	29,6	41	449	626	0	0	0	0
Citric Fruit	649	28,7	0	0	3531	156	975	43,1	328,3	13,5
Forestry	160	5,4	0	0	945	31,7	0	0	0	0
Egg Production	-	76,4	0	0	0	0	0	0	-	0,76
Poultry	-	106	0	0	0	0	0	0	-	0,8
Grain Dryers	-	8,92	-	0	0	0	0	0	0	0
TOTAL (*)	117,43	24,50	10,72	2,11	923,2	180,9	157,7	42,0	51,1	9,3

(*) Totals in columns with Hectare do not include: Egg production, Poultry and Grain Dryers.

TABLE 16 (continued)

RELATIONS BETWEEN INPUTS AND PRODUCTION FACTORS

RURAL PRODUCTION SECTOR

	Irrigation		Water Pumping Other Uses		Station.Machin. Other Uses		Lighting		Caloric Uses	
	HP-hs/He	HP-hs/Tn	HP-hs/He	HP-hs/Tn	HP-hs/He	HP-hs/Tn	Kwh/He	Kwh/Tn	Koe/He	Koe/Tn
Agricultural	0	0	0	0	2,16	0,40	0,04	0,084	0	0
Cattle-raising	0	0	2,48	7,06	0,54	1,53	0,28	0,8	0	0
Rice Cultivation	2830	860	0	0	1,37	0,42	0	0	0	0
Vegetable Gardens	900	117	0	0	0	0	0	0	0	0
Dairies	0	0	8,8	12	18,1	25	1,1	1,51	0,38	0,5
Citric Fruit	93,84	4,15	110,9	4,9	7,0	0,3	0	0	0	0
Forestry	0	0	0	0	0	0	0	0	0	0
Egg Production	0	0	-	11,8	-	10,5	-	86,9	-	3,0
Poultry	0	0	-	38	-	108	-	78	-	13
Grain Dryers	0	0	0	0	-	3,64	0	0	-	20,95
TOTAL	227,9	44,9	18,7	4,0	12,77	0,96	0,20	1,31	0,02	0,35

TABLE 16 (concluded)

RELATIONS BETWEEN INPUTS AND PRODUCTION FACTORS

RURAL PRODUCTION SECTOR

	Transport		Total Inst. Power	Energy Consump. Net Total		Energy Consump. Useful Total		Energy Utilization Yield	Value of the Production Sold	
	Tn-Km / He	Tn-Km / Tn	HP / He	Koe / He	Koe / Tn	Koe / He	Koe / Tn		10^3 $a / He	10^3 $a / Tn
Agricultural	14,2	29,6	1,08	118,25	246,6	28,52	59,5	0,24	200,0	434,2
Cattle Raising	5,5	15,7	0,14	26,07	74,11	7,69	21,9	0,30	144,8	568,2
Rice Cultivation	417,8	126,2	3,67	725,36	219,13	182,58	55,16	0,25	781,6	195,6
Vegetable Gardens	52,7	6,9	9,68	661,47	86,13	155,9	20,30	0,24	2335,0	235,0
Dairies	7,6	10,6	0,83	76,51	106,75	17,85	24,90	0,23	192,0	272,7
Citric Fruit	462,2	20,4	3,61	1394,7	61,67	685,09	30,29	0,49	2935,0	130,0
Forestry	582,1	19,5	0,60	143,5	4,8	36,3	1,21	0,25	876,7	29,4
Egg Production	-	30,8	-	-	16,5	-	3,91	0,24	-	527,3
Poultry	-	128,8	-	-	34,34	-	16,73	0,49	-	620,4
Grain Dryers	-	38,32	-	-	22,28	-	7,13	0,32	-	-
TOTAL	126,2	26,2	1,14	309,5	61,3	129,4	25,6	0,42	656,7	143,1

Industrial and Mining Sector

Analysis of the Correlation Between Energy Consumption and Production

The polls carried out in this sector covered eight UIIC divisions of the province's manufacturing industry as well as its mining activity. In the first part of this report a subdivision at the fifth digit of the UIIC Code was made, enabling thirty-eight activities to be analyzed.

For the present statistical analysis it was necessary to rearrange the activities into homogeneous groups containing the minimum number of elements required by the analysis. Using this criterion, twelve groups were made with a total of 157 polls. They cover only three divisions and the mining sector. The remaining five divisions, with very low influence on the sector's energy consumption, did not have sufficient information in the polls so they were given a different treatment.

For each establishment of the twelve groups the total energy consumption was determined, including fuels (direct use) and electricity, both in terms of net or final and useful energy. The explanatory variable used was production expressed in tons. For each group potential adjustments were made between the different energy variables and the production level, obtaining the production-elasticity and the different statistical parameters of the function.

In addition, adjustments were made between the man-hours worked and the production level. For the five divisions not included in this type of statistical treatment, the available information was used to determine specific consumption coefficients in koe/tn both for total energy and for fuels and electricity in terms of net and useful energy.

The result of the adjustments is summarized in Tables 17 and 18 which show the elasticity value and the correlation coefficient obtained in each of the eighty-four adjustments made. Of the seventy-two related to energy variables, about 75% had correlation coefficients (r) higher than 0.6 and of the twelve related to man-hours about 85% were significant.

The best correlation coefficients were obtained for the mining activity (r=0.96) for net and useful fuel consumptions. In general, the adjustments obtained with the useful energy consumption were fairly good. The adjustments made with electricity consumption were slightly better than the rest.

TABLE 17

INDUSTRIAL AND MINING SECTOR

Values of Correlation Coefficient (r) Obtained with the Adjustments

Activities in accordance with CIIU Code / r	Energy Consumptions						Labor
	Total		Fuels		Electricity		
	N	U	N	U	N	U	Man - hours
31111 (a)	0.6059	0.6484	0.4769	0.4818	0.8092	0.8097	0.7242
31111 (b)	0.9016	0.8991	0.3378	0.3562	0.8724	0.8727	0.9399
3112	0.7671	0.7832	0.7347	0.7380	0.7615	0.7644	0.7034
31113	0.1803	0.2175	0.0081	0.0203	0.3632	0.3626	0.2936
31151	0.8350	0.8652	0.8165	0.8458	0.9176	0.9177	0.7645
3116	0.6403	0.6988	0.1629	0.1746	0.8457	0.8458	0.8081
3117	0.8553	0.8780	0.7688	0.7842	0.2730	0.2653	0.6452
31220	0.7651	0.7752	0.6949	0.6971	0.9200	0.9199	0.9518
31340 & 31132	0.0819	0.0885	0.0976	0.0948	0.1320	0.1327	0.1145
331 (1)	0.7047	0.7371	-	-	-	-	0.7742
331 (2)	0.9481	0.9489	-	-	0.9481	0.9489	0.8263
36	0.8904	0.9071	0.8729	0.9025	0.6086	0.6349	0.8012
Mining	0.8191	0.7840	0.9603	0.9603	0.5791	0.5790	0.9036

(1) Complete series.

(2) Series without the only two establishments using fuels.

TABLE 18

INDUSTRIAL AND MINING SECTOR

Values of Elasticity Coefficient (b) Obtained with the Adjustments

b / Activities in accordance with CIIU Code	Energy Consumptions						Labor
	Total		Fuels		Electricity		Man - hours
	N	U	N	U	N	U	
31111 (a)	0.958	0.977	1.012	1.011	1.029	1.042	0.853
31111 (b)	0.743	0.738	0.634	0.641	0.776	0.776	0.573
31113	0.302	0.345	0.046	0.110	0.511	0.510	0.334
3112	0.533	0.549	0.509	0.513	1.445	1.439	0.456
31151	1.140	1.238	1.105	1.195	1.500	1.500	0.538
3116	0.999	1.031	0.660	0.671	1.254	1.254	0.713
3117	0.996	0.932	1.537	1.469	0.491	0.487	0.563
31220	0.919	0.899	1.523	1.470	0.883	0.883	0.585
31340 & 31132	0.110	0.115	0.231	0.217	0.169	0.169	0.080
331 (1)	0.958	0.937	-	-	-	-	0.462
331 (2)	0.690	0.703	-	-	0.690	0.703	0.543
36	1.037	1.090	0.987	1.077	1.568	1.683	0.684
Mining	1.246	1.184	1.725	1.725	0.888	0.888	0.533

(1) Complete series.

(2) Series without the only two establishments using fuels.

The greatest elasticities (1.725) correspond to the net and useful fuel consumption in the mining activity followed by electrical consumption in the activity "Manufacture of Non-Metallic Mineral Products" with values of b=1.683 and b=1.568 for useful and net energy. The lower values correspond to the group "Preparation of Milk Products and Ice Cream" for the total consumption with b=0.533 and b=0.549 for net and useful energy.

The production elasticities with respect to man-hours worked never reaches unity but always has positive values. In 31% of the groups the hypothesis that b=0 had to be accepted with 95% confidence based on information given by the polls. The highest value corresponds to milled products (b=0.713) and the lowest to the timber industry with b=0.462. The detailed results obtained for each of the twelve groups analyzed can be found in the main report.

As has been said before for the other five divisions, only the specific consumption of fuels, electricity and total energy per ton of product were obtained. As a general remark it can be said that all the activities use electricity, although at minimum levels in some cases, but not all of them use fuels.

Descriptive Analysis of Total Energy Consumption per Ton of Production

With the available data 26 frequency distributions were made (13 for net energy and 13 for useful energy). For each of them the statistical measures of position, dispersion, form and kurtosis were calculated. The different frequencies distribution were graphically analyzed with their respective box diagrams or histograms according to whether the number of observations were lower or greater than twelve.

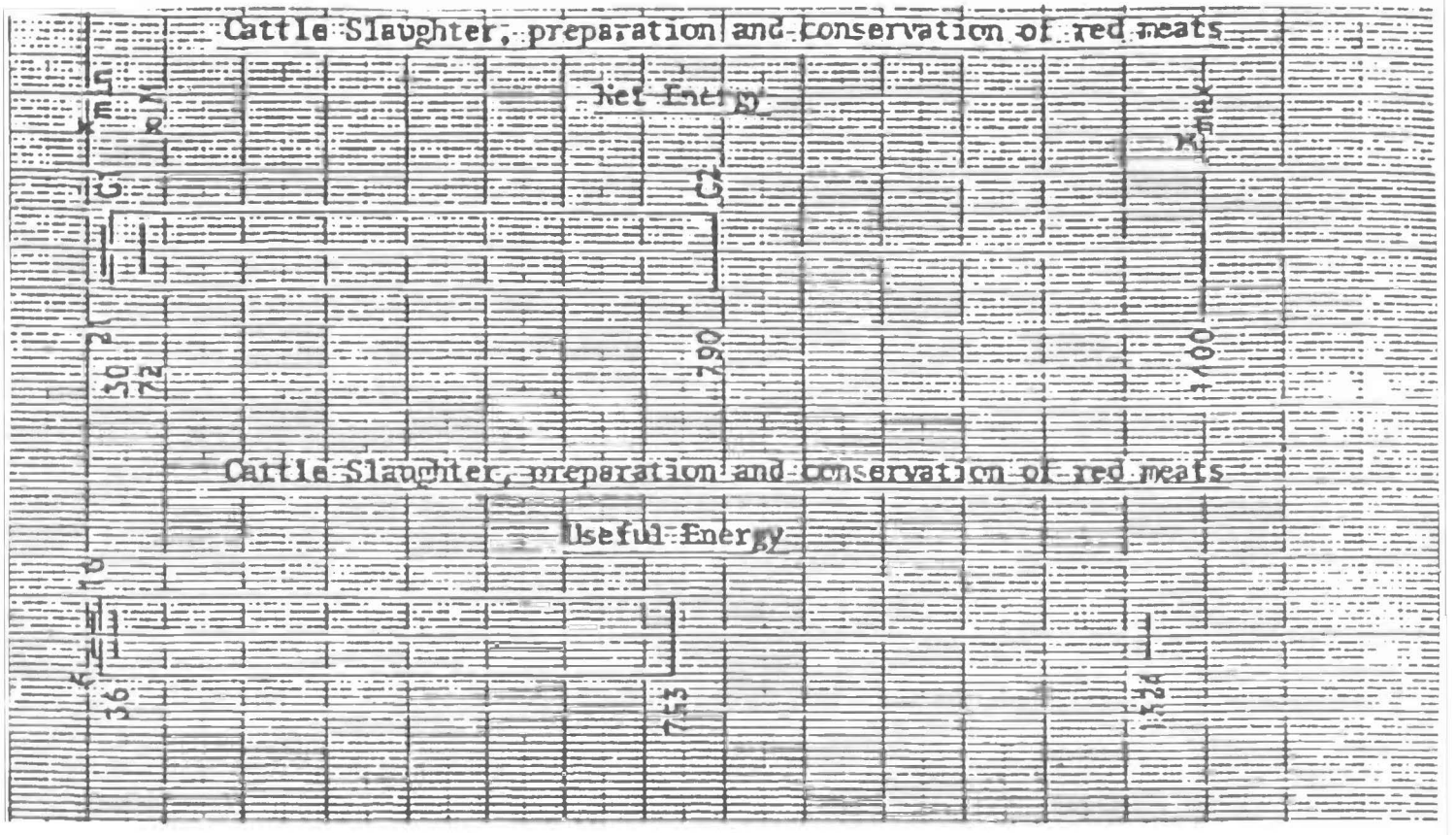
In Table 19 the results obtained are given and Figures 18 and 19 show examples of the corresponding box diagram and histograms. It is observed that the maximum specific consumptions (694 koe net/tn; 438 koe useful/tn) correspond to the preparation of non-alcoholic drinks and the canning of fruit, vegetables and greens.

This activity among all those analyzed is also the one with greatest variation range and has one of the highest dispersions.

FIGURE 18

INDUSTRIAL AND MINING SECTOR

Box Diagrams of Specific Energy Consumption (koe/Tn)



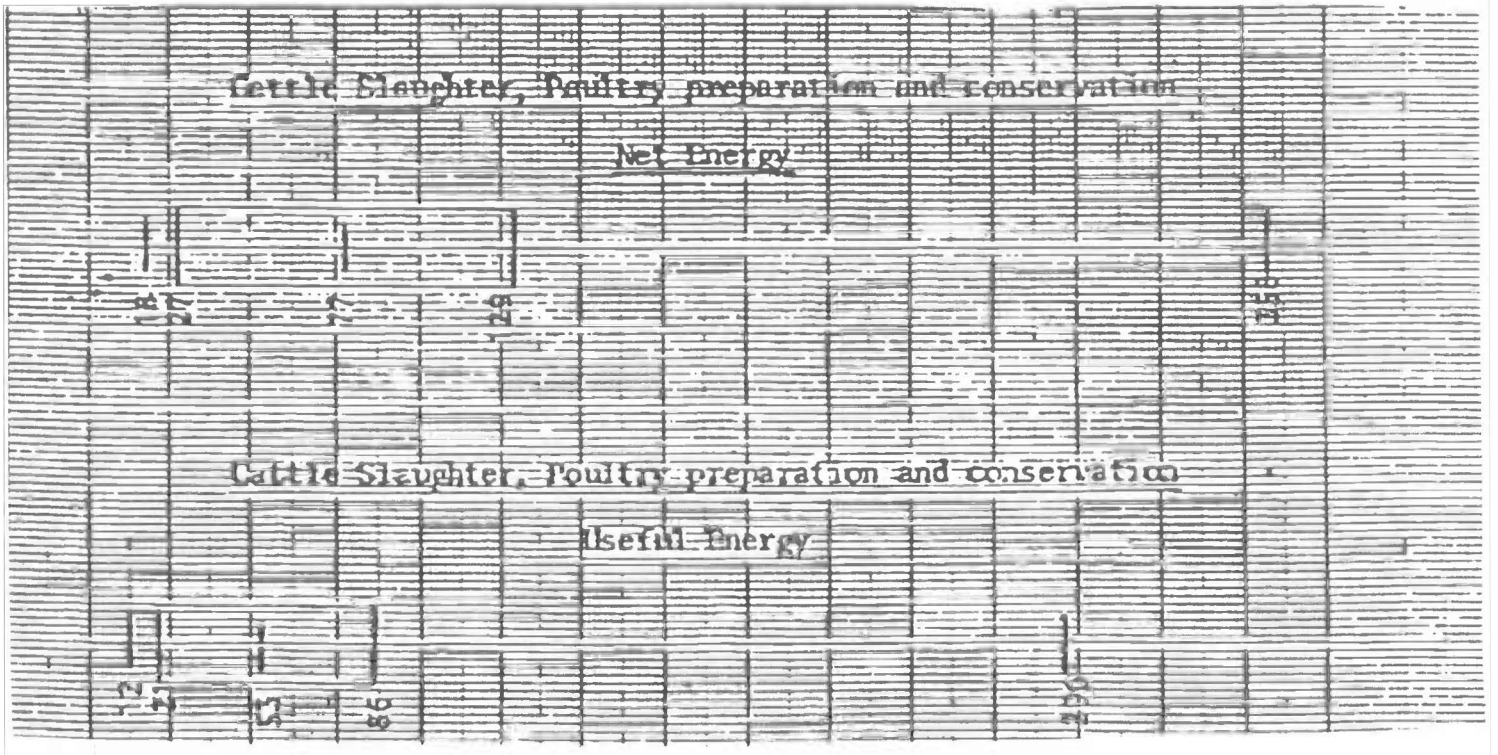


FIGURE 19

INDUSTRIAL AND MINING SECTOR

Frequencies Distribution of Useful Energy Specific Consumption

Milling Products

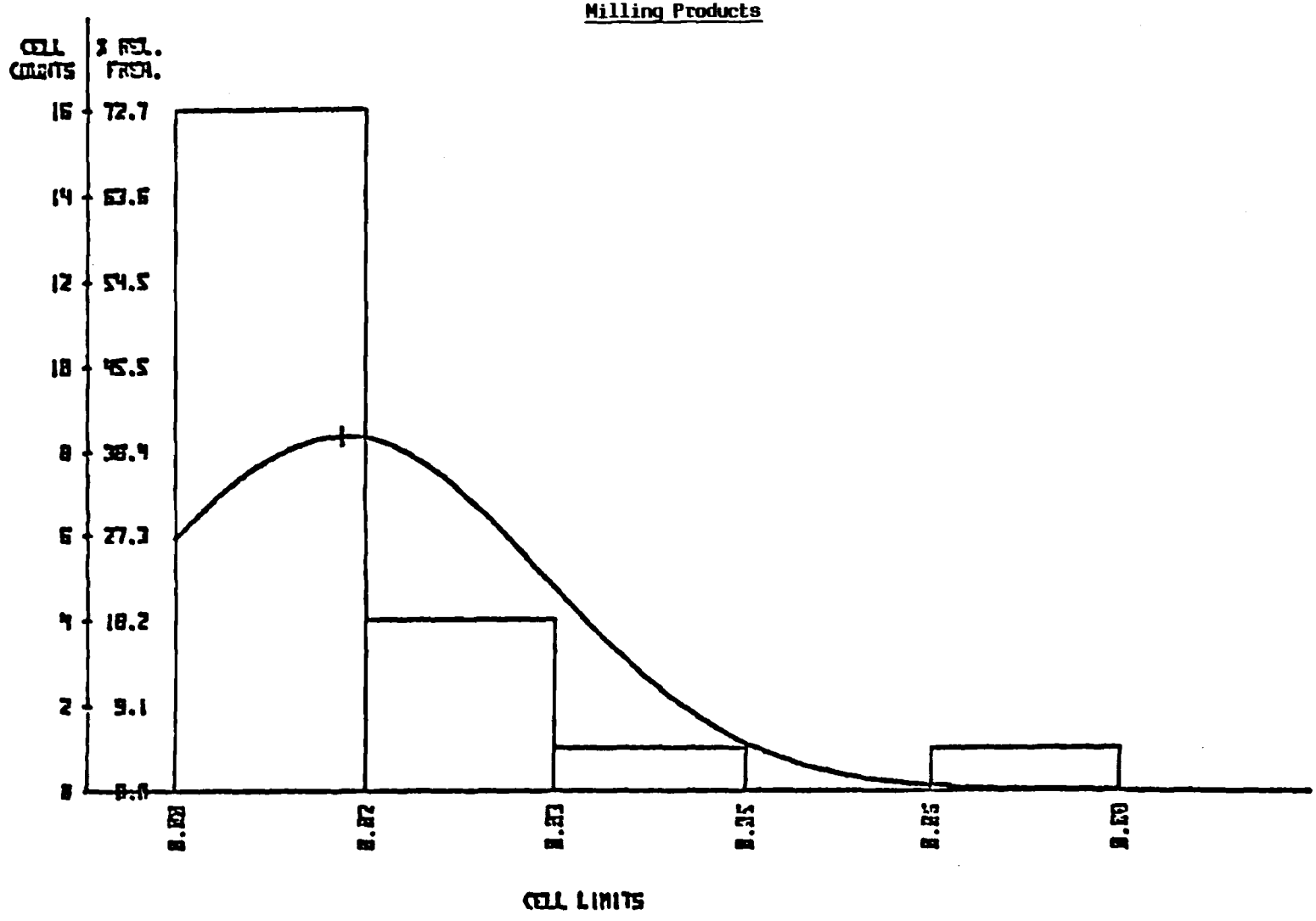


TABLE 19

INDUSTRIAL AND MINING SECTOR

Descriptive Analysis of Specific Energy Consumption (Net and Useful)
(Koe/Tn)

Characteristics / Activity	N	x	Median	Range		VC	Asymmetry	Kurtosis
Cattle Slaughter, Preparation and Preservation of Red Meats								
(Net Energy)	6	0.296	0.072	1.379	0.496	1.676	1.749	1.125
Idem - Idem (Useful Energy)	6	0.262	0.036	1.318	0.477	1.821	1.756	1.138
Cattle Slaughter, Poultry Preparation and Conservation								
(Net Energy)	9	0.099	0.0-7	0.34	0.099	1	1.837	2.312
Idem - Idem (Useful Energy)	9	0.074	0.053	0.284	0.082	1.108	2.073	2.986
Preparation of Cooked Meats, Delikatssen and similar.								
(Net Energy)	11	0.271	0.134	1.308	0.364	1.343	2.076	3.150
Idem - Idem (Useful Energy)	11	0.166	0.088	0.804	0.220	1.325	2.165	3.574

TABLE 19 (continued)

INDUSTRIAL AND MINING SECTOR

Descriptive Analysis of Specific Energy Consumption (Net and Useful)
(Koe/Tn)

Characteristics / Activity	N	$\bar{x}$	Median	Range	σ	VC	Asymmetry	Kurtosis
Manufacturing of Mineral Products, except oil and coal by products.								
(Net Energy)	13	0.065	0.05	0.17	0.05	0.769	0.91	-1.71
Idem - Idem (Useful Energy)	13	0.034	0.025	0.078	0.025	0.735	0.66	-1.04
Sand and Gravel Quarries								
(Net Energy)	5	0.005	0.006	0.008	0.003	0.60	-0.175	-2.276
Idem - Idem (Useful Energy)	5	0.004	0.004	0.007	0.003	0.75	0.310	-2.773
Elaboration of Cow Milk Products. (Net Energy)	7	0.279	0.208	0.831	0.273	0.978	1.050	0.041
Idem - Idem (Useful Energy)	7	0.165	0.128	0.492	0.161	0.976	1.079	0.114
Preparation and Refining of Vegetable Oils and Fats								
(Net Energy)	7	0.126	0.077	0.313	0.111	0.88	0.969	-1.281
Idem - Idem (Useful Energy)	7	0.070	0.050	0.137	0.055	0.79	0.734	-2.854

TABLE 19 (continued)

INDUSTRIAL AND MINING SECTOR

Descriptive Analysis of Specific Energy Consumption (Net and Useful)
(Koe/Tn)

Characteristics / Activity	N	$\bar{x}$	Median	Range	σ	VC	Asymmetry	Kurtosis
Milling Products								
(Net Energy)	22	0.024	0.017	0.130	0.029	1.208	2.073	4.831
Idem - Idem (Useful Energy)	22	0.013	0.008	0.073	0.015	1.154	2.454	6.625
Manufacture of Bakery								
Products (Net Energy)	35	0.248	0.220	0.690	0.150	0.60	1.542	2.604
Idem - Idem (Useful Energy)	35	0.124	0.110	0.430	0.079	0.64	2.596	8.308
Preparation of Balanced								
Food for Animals								
(Net Energy)	14	0.070	0.008	0.399	0.132	1.88	1.643	1.034
Idem - Idem (Useful Energy)	14	0.041	0.006	0.229	0.077	1.88	1.635	0.989

TABLE 19 (concluded)

INDUSTRIAL AND MINING SECTOR

Descriptive Analysis of Specific Energy Consumption (Net and Useful)
(Koe/Tn)

Characteristics / Activity	N	$\bar{x}$	Median	Range	ρ	VC	Asymmetry	Kurtosis
Elaboration of Non-alcoholic Drinks and Soda Water and Fruit, Vegetables, etc. (juices) canning.								
(Net Energy)	10	0.694	0.113	3.815	1.192	1.718	1.828	1.907
Idem - Idem (Useful Energy)	10	0.438	0.024	2.449	0.787	1.797	1.751	1.551
Industry of Timber and Timber and Cork Products, except Furniture.								
(Net Energy)	10	0.041	0.002	0.384	0.114	2.78	2.660	5.09
Idem - Idem (1) (Useful Energy)	10	0.020	0.002	0.179	0.053	2.65	2.657	5.08
Idem - Idem (2) (Net Energy)	8	0.002	0.002	0.0036	0.0013	0.65	0.568	-2.94
Idem - Idem (2) (Useful Energy)	8	0.002	0.002	0.0034	0.0011	0.55	0.387	-1.04

The lowest average specific consumptions are given in the timber industry and timber products, with 2 koe/tn both in net and useful energy. This coincidence is due to the utilization of electricity as the only energy source, with a high utilization yield. We also found here the lowest range of variation and dispersions in the sector.

In the mining activities, sand and gravel quarries have low, specific average consumption with 5 koe net/tn and 4 koe useful/tn, and dispersions of about 60 and 75%. This group is the only one with a negative asymmetry coefficient for net energy. All the others are strongly asymmetric to the right (or they have positive values), being the maximum value (2.66) for the timber industry.

The kurtosis coefficients are positive in 77% of cases, in other words, the majority are leptokurtic distributions.

A detailed analysis of each group's distribution is given in the main report.

Commercial and Services Sector

Analysis of the Correlation Between Energy Consumption and the Explanatory Variables

In this sector net and useful consumption of electricity, as well as fuels and total energy of each of the 139 establishments polled were related to personnel engaged and area covered as the explanatory variables. In some cases annual amount of sales and the number of persons attended during the year were also used as an explanatory variable. For each of the nine activities identified in the sector, a potential type adjustment was made, allowing direct determination of elasticity, which is constant. However, in some cases, linear adjustments have also been tested. A total of one hundred and eighty adjustments have been made (twelve of them linear) and the main observations which can be made of the results obtained are detailed below:

In general, a high variance is observed in the energy consumption of establishments of similar size in the same category, whatever explanatory variable is used. In some cases, such as wholesale and retail traders, this fact can be explained by the lack of homogeneity of the activities grouped within the same category. In other cases, such as hotels, restaurants, hospitals, schools, etc., this great variability of consumptions is the consequence of the differences observed on analyzing the appliances stocks of this type of establishments.

The annual sales amounts in all the activities in which this variable is available show very low correlation with energy consumption. In some cases it is due to the lack of reliability of the values declared in each poll.

In general, the number of persons attended is not a good variable for explaining the variations observed in energy consumption, probably due to the errors committed in measuring that variable.

In almost all the activities, personnel engaged explains best the variations observed in total energy consumption and in electric consumption, both in net and useful energy. The only exceptions correspond to the wholesalers and bar and cafeterias, where the best adjustments are obtained with the area.

The variations in fuel consumption are the most difficult to explain in almost all the activities. In many of them the adjustments are not statistically significant, such as in the case of commercial activity (wholesaler and retailer), workshops, schools, bars and cafeterias. Only in the restaurants, hospitals and dry cleaning establishments are high explanation levels obtained, using personnel engaged in the explanatory variable. In the remaining activities significant adjustments are obtained with the area, above all with linear models. However, the use of these curves is generally invalidated because they lead to negative consumptions for establishments of observed sizes.

This situation can be attributed in part to the competition which occurs between certain fuels and electricity in some important uses in the region being analyzed. To check this hypothesis, which in principle, would be confirmed by the quality of the total consumption adjustments, it would be interesting to make a correlation analysis similar to the one carried out between useful energy consumption by use and the explanatory variables.

In almost all the activities the estimate of elasticity-personnel of electricity consumption is less than that of total consumption, the highest values being obtained with respect to the consumption of fuels, although with intervals of confidence for the real values of considerable amplitude.

Elasticity-personnel of electricity consumption varies between 0.6 and 1.1 for hospitals and restaurants and is somewhat higher for hotels, where it varies between 0.5 and 1.3.

Elasticity of electricity consumption is even greater in schools, estimated at 1.1, it being possible to state with 95% certainty that it is not less than 0.7 nor higher than 1.6. The lowest values are obtained for the retail traders where it is not above 1 nor lower than 0.4. In wholesale traders and dry cleaners, the variation margins are so wide that little can be stated about the true value, partly due to the small number of elements in the corresponding samples.

For total consumptions, elasticity-personnel estimated for hotels, schools, bars and cafeterias, is approximately equal to 1.4. Nevertheless, while in the first case it can be stated that the true value is not less than 1 nor higher than 1.8, in the other two it can vary between 0.5 and 2.1.

In the remaining activities, with the exception of the wholesalers, the estimated elasticities are close to 1, while the real values are between 0.4 and 1.4.

The results obtained in the correlation analysis for each of the activities into which the commercial and services sector has been divided is presented in detail in the main report.

Descriptive Analysis of Specific Consumption

Starting from the total energy consumption of each establishment obtained from the polls, the specific consumption in net and useful energy, referring to persons engaged, covered area and annual sales as explanatory variables, were calculated. To analyze the frequency distribution of these variables they were grouped together by activity. According to the number of values available in each case, the corresponding box diagram or histogram was made giving the position and dispersion parameters. The asymmetry coefficient and kurtosis were also calculated.

The statistical values which characterize each frequency distribution are given in Tables 20 to 25.

As can be seen, the average maximum consumption per person engaged (5300 koe net and 1000 koe useful) are produced in the dry cleaners, characterized by high energy consumption and one or two

TABLE 20

COMMERCIAL AND SERVICES SECTOR

Descriptive Analysis of Net Energy Consumption per Person Engaged

Characteristic / Activity	N	$\bar{x}$	Median	Range	σ	Variation Coefficient	Asymmetry	Kurtosis
Wholesale Traders *	7	1287.58	75.50	6399.47	2414.83	187.55	-	-
Retail Traders	28	113.62	87.50	269.00	78.36	68.97	0.63	2.12
Workshops *	5	82.39	63.0	184.50	70.54	85.62	-	-
Dry Cleaners *	8	5268.51	5754.6	6002.82	2420.86	45.95	-	-
Schools	20	45.42	20.05	186.92	50.59	111.37	1.32	3.81
Hospitals	12	253.94	223.60	335.0	198.98	78.36	1.21	3.94
Hotels	21	1474.32	1123.40	3868.2	1289.8	87.48	0.62	1.91
Restaurants	16	1479.31	1541.70	5362.3	1296.08	87.61	1.46	5.38
Bars & Cafeterias	14	1057.28	746.50	3118.7	855.14	80.88	1.27	4.11

* The asymmetry coefficients and kurtosis were not calculated, nor was the frequencies histogram, due to the small number of polls.

TABLE 21

COMMERCIAL AND SERVICES SECTOR

Descriptive Analysis of Useful Energy Consumption per Person Engaged

Characteristic / Activity	N	$\bar{x}$	Median	Range	σ	Variation Coefficient	Asymmetry	Kurtosis
Wholesale Traders *	7	800.41	38.8	3992.40	1505.91	118.15	-	-
Retail Traders	28	92.57	53.7	297.5	77.89	84.14	0.95	2.94
Workshops *	5	51.33	34.5	124.5	48.08	93.67	-	-
Dry Cleaners *	8	1025.27	1019.16	1199.58	489.24	47.72	-	-
Schools	20	19.18	8.8	67.95	21.65	112.85	1.02	2.55
Hospitals	12	140.84	117.75	457.30	120.43	85.50	1.64	5.21
Hotels	21	759.64	680.90	2415.90	683.15	89.93	0.86	2.66
Restaurants	16	534.98	431.15	1514.30	367.44	68.68	1.14	4.16
Bars & Cafeterias	14	520.86	365.75	1714.10	443.19	85.09	1.49	4.78

* The asymmetry coefficients and kurtosis were not calculated, nor was the frequencies histogram, due to the small number of polls.

TABLE 22

COMMERCIAL AND SERVICES SECTOR

Descriptive Analysis of Net Energy Consumption per m^2 (koe/m^2)

Characteristic / Activity	N	$\bar{x}$	Median	Range	σ	Variation Coefficient	Asymmetry	Kurtosis
Wholesale Traders *	7	32.92	0.51	109.66	52.35	159.03	-	-
Workshops *	5	1.20	1.22	2.00	0.81	67.50	-	-
Dry Cleaners *	8	159.60	107.51	546.34	177.82	111.42	-	-
Schools	20	2.02	0.91	17.09	3.67	182.17	8.43	14.29
Hospitals	12	10.16	6.80	36.30	10.08	99.23	1.76	5.26
Restaurants	16	65.09	35.76	367.10	91.64	140.80	2.33	7.95
Bars & Cafeterias	14	24.13	15.34	69.88	20.21	83.74	1.16	3.31

* The asymmetry coefficients and kurtosis were not calculated, nor was the frequencies histogram, due to the small number of polls.

TABLE 23

COMMERCIAL AND SERVICES SECTOR

Descriptive Analysis of Useful Energy Consumption per m^2 (koe/m^2)

Characteristic / Activity	N	$\bar{x}$	Median	Range	σ	Variation Coefficient	Asymmetry	Kurtosis
Wholesale Traders *	7	20.65	0.26	68.18	52.51	157.44	-	-
Workshops *	5	0.73	0.92	1.18	0.49	67.13	-	-
Dry Cleaners *	8	26.18	20.80	34.87	19.16	73.19	-	-
Schools	20	0.77	0.34	6.19	1.36	176.62	3.14	12.78
Hospitals	12	5.89	3.40	22.60	6.37	108.15	1.82	5.40
Restaurants	16	27.20	12.91	157.40	40.91	150.43	2.22	7.14
Bars & Cafeterias	14	11.79	7.50	38.20	10.21	86.60	1.42	4.21

* The asymmetry coefficients and kurtosis were not calculated, nor was the frequencies histogram, due to the small number of polls.

TABLE 24

COMMERCIAL AND SERVICES SECTOR

Descriptive Analysis of Net Energy Consumption per 10^6 $ Sold

Characteristic / Activity	N	x	Median	Range	σ	Variation Coefficient	Asymmetry	Kurtosis
Wholesale Traders *	7	119.72	12.59	388.85	173.32	144.78	-	-
Retail Traders	28	15.84	6.08	144.81	29.50	186.16	3.14	13.31
Worshops *	4	30.83	30.07	53.38	28.49	92.41	-	-
Dry Cleaners *	8	557.04	302.57	1534.38	523.55	93.99	-	-
Hotels	21	172.66	121.80	953.8	208.18	120.57	2.47	9.65
Bars & Cafeterias	14	80.71	50.9	368.0	92.81	115.57	2.24	7.36

* The asymmetry coefficients and kurtosis were not calculated, nor was the frequencies histogram, due to the small number of polls.

TABLE 25

COMMERCIAL AND SERVICES SECTOR

Descriptive Analysis of Useful Energy Consumption per 10^6 $ Sold

Characteristic / Activity	N	$\bar{x}$	Median	Range	σ	Variation Coefficient	Asymmetry	Kurtosis
Wholesale Traders *	7	81.41	6.47	266.43	120.01	147.42	-	-
Retail Traders	28	12.73	4.47	129.04	25.78	202.57	3.38	15.03
Workshops *	4	18.82	17.25	35.80	17.47	92.83	-	-
Dry Cleaners *	8	95.90	74.06	159.72	60.87	63.48	-	-
Hotels	21	71.68	72.90	247.40	62.21	86.80	1.02	3.70
Bars & Cafeterias	14	40.61	24.85	195.40	48.67	119.84	2.32	7.69

* The asymmetry coefficients and kurtosis were not calculated, nor was the frequencies histogram, due to the small number of polls.

persons engaged. This activity is the one with the least dispersion and range of variation, with asymmetry to the left for net consumption, an asymmetry which is corrected on considering useful ones and eliminating the distortions introduced by energy sources with different utilization yields.

Next in importance are hotels and restaurants with average values close to 1500 koe net/person engaged, with a dispersion of 87% in both cases, although with a greater variation range in restaurants.

However, when considering useful energy, both activities differ, the hotels having a useful consumption of 760 koe/person, a value almost 50% higher than that of restaurants. The differences in utilization yields are the result of the use of firewood for cooking in restaurants. In both cases the median is about 20% lower than the average.

In wholesale establishments, although they have high average consumption (1300 koe net and 800 koe useful), these values are strongly affected by quasi-industrial activities with high caloric consumptions. Since the participation of this kind of activities does not reach 50%, the median has very much lower values (75 koe net and 39 koe useful/person). Therefore, for a correct characterization of specific consumption per person engaged in this activity, it is necessary to stratify the sample to reduce the dispersion observed.

Net consumption per person engaged in bars and cafeterias, has an asymmetric distribution to the right, where the median is approximately 750 koe while the average value is close to 1060 koe. The form of distribution is similar when considering useful energy but the values of the central tendency are reduced almost by half.

The remaining activities have very much lower average consumptions, varying between 250 koe net per person engaged in hospitals and 45 koe net per person engaged in schools. These latter have a dispersion of around 110%. In all cases, distribution of the values is asymmetric to the right.

As regards consumption/m^2, a greater dispersion of the values and curves with high asymmetric coefficients is observed in almost all the activities.

In these circumstances also, the dry cleaners, restaurants and bars and cafeterias show the highest consumptions, with averages varying between 160 and 24 koe net/m^2 and between 27 and 12 koe useful/m^2 while the medians are between about 50% and 30% lower than these values.

The wholesale establishments show a difference between the average and the median similar to that observed for consumption/personnel engaged and for the same reasons.

The remaining activities have average consumptions which vary between 10 and 1 koe net/m^2 and between 6 and 1 koe useful/m^2, the highest values corresponding to hospitals and the lowest to workshops and schools.

On analyzing the consumptions with reference to the annual amount of sales expressed in koe/10^6 pesos, it is seen that the dry cleaners are the ones which have the highest consumptions, which reach an average consumption of 560 koe net/10^6 pesos and 96 koe useful/10^6 pesos, both higher than the corresponding medians, hotels and bars and cafeterias, whose average value is 80 and 40 koe/10^6 pesos, according to whether net or useful energy respectively is concerned. Nevertheless, the average values corresponding to hotels are not very representative because in the analysis of the frequency curve, two clearly differentiated categories are detected. (Figures 20 and 21 are given as examples of box diagrams and histograms.)

In the main report, more detailed results are given for each activity.

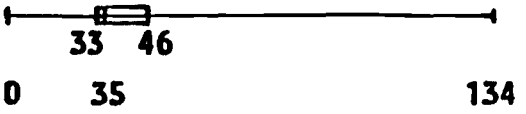
FIGURE 20

COMMERCIAL AND SERVICES SECTOR - WORKSHOPS

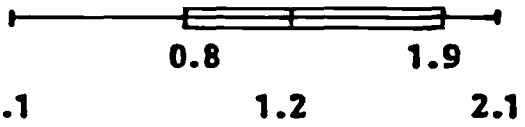
Box Diagrams of Energy Consumption

a) Net Consumption/person engaged (Koe/person)

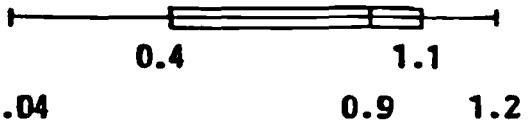
b) Useful Consumption/person engaged (Koe/person)



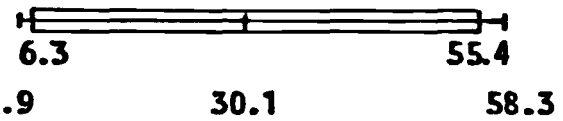
c) Net Consumption/m2 (Koe/m2)



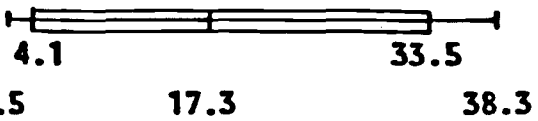
d) Useful Consumption/m2 (Koe/m2)



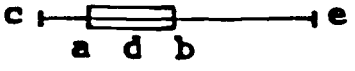
e) Net Consumption/10^6 $ sold (Koe/10^6 $)



f) Useful Consumption/10^6 $ Sold (Koe/10^6 $)



Note:

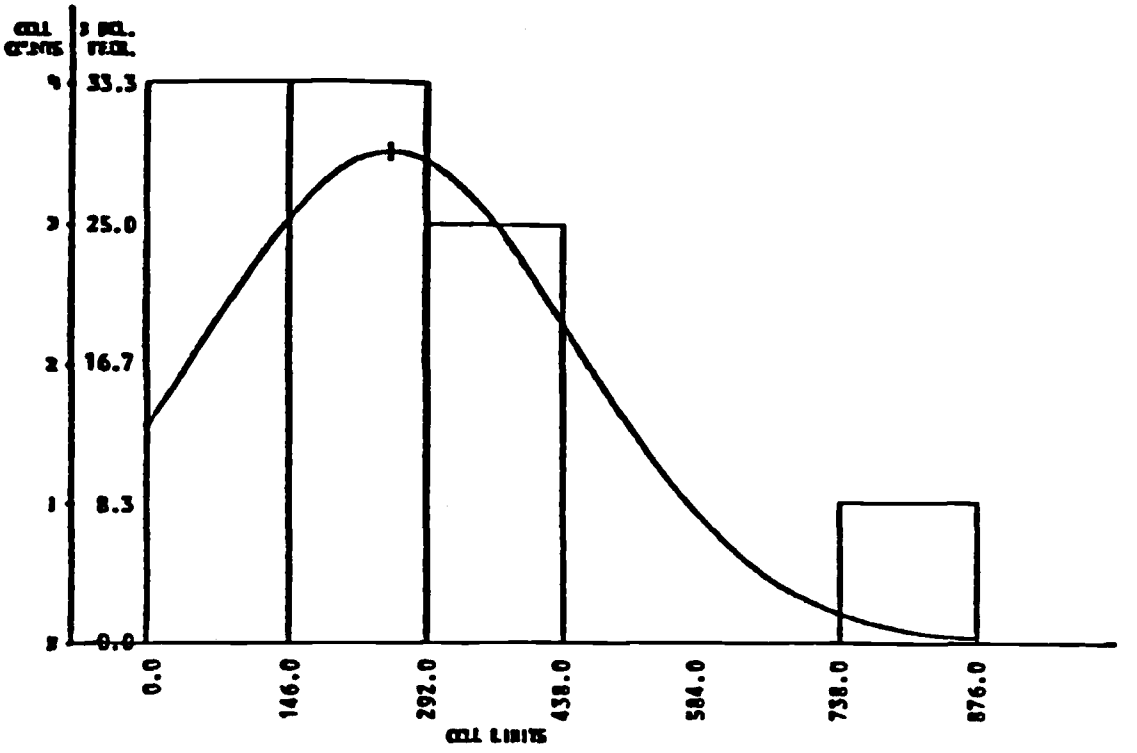


a: first quartile
b: third quartile
c: minimum value
d: median
e: maximum value

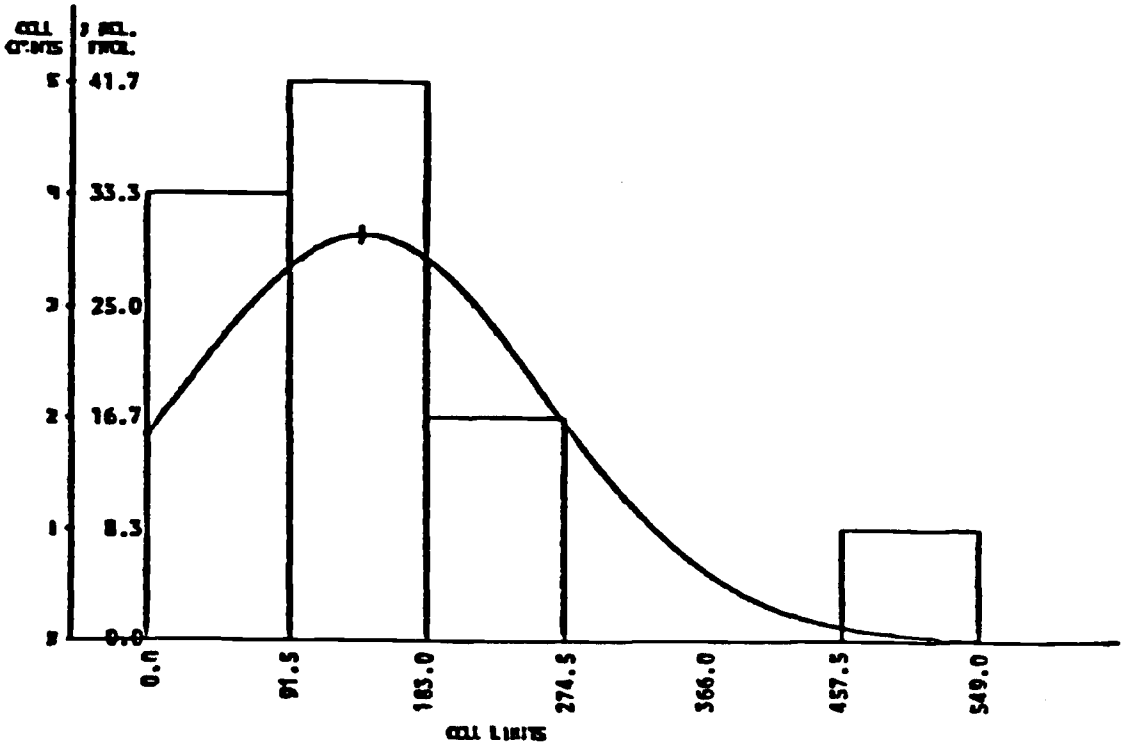
FIGURE 21

COMMERCIAL AND SERVICES SECTOR - HOSPITALS

Frequencies Distribution of Energy Consumption per Person Engaged



a) Net Energy



b) Useful Energy