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A FIRST APPROACH TO DEFINING BASIC ENERGY NEEDS

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1. Introduction.

In recent years the subject of the "satisfaction of basic needs" as a new goal or objective which all the socio-economic systems should consider as the fundamental criterion for their structure and growth has given rise to a wide range of publications.

This immediately calls for a definition, as precise as possible and in quantitative terms, of the minimum levels required for judging whether these basic needs (food, housing, clothing, health, education, energy) are being duly satisfied.*

In this sense, the field which has been most thoroughly explored corresponds to food, where a series of coefficients has long been defined and accepted regarding the minimum amount of calories and proteins which ensure meeting the basic food requirements.

Some proposed criteria and values also exist for housing, though the definition is less precise, nor do "generally accepted" values exist.

On passing from these concrete, material needs to others of a more indirect or cultural nature (health, education) the problem becomes more complicated since it is difficult to determine both the specific variable to be measured and the unit in which it is to be measured.

With regard to energy, we have on the one hand the fact that it is not always included in the basic needs (at least directly) and on the other, that although it is fairly clear what is the variable to be measured and what is the unit in which it may be expressed, only a very restricted bibliography exists defining the basic level of satisfaction of this need [1) 2)].

In the following paragraphs we shall attempt to pose the problem, analyze it, propose some adequate methodologies for measuring it and offer some tentative values related to Latin America.

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1) Ph.F. Palmedo, R. Nathans, E. Beardsworth and Solsale Jr. (1978) Energy needs, uses and resources in developing countries, B.N.L., N.York, Chapter C.

2) A.K. Reddy and A. Poole (1975), Energy and Agriculture in the Third World, Ballinger Publishing Co., Cambridge, Mass.

*) In relation to the definitinn of needs and basic needs, see Exhibit I at the end of this paper.

2. The problem.

The problem we shall set ourselves is to attempt to define qualitatively and quantitatively the basic energy requirements of a human being.

Since the word "energy" has an ample variety of meanings, we must begin by defining it exactly, either by exclusion or inclusion.

In the former case, we run the risk of not identifying all the necessary or advisable exclusions and the term would continue to be imprecise. We therefore considered it would be preferable to try to define it by inclusion.

When speaking about "energy" needs we shall be referring to man's use of specific energy sources external to him which allow the satisfaction of either "direct" energy needs (caloric, mechanical, electronic) or "indirect" needs, i.e. the energy content of all other goods and services necessary for his subsistence and development.

In other words we include in this analysis the consumption of the so-called conventional energy sources (fossil and nuclear fuels, electricity); vegetable fuels, vegetable and animal wastes; and the so-called non-conventional sources (solar, wind, geothermal, biogas, urban wastes, biomass).

We have already suggested an essential, fundamental distinction referring to the application to be given to their use or consumption. We refer to the distinction between the "direct" and the "indirect" energy requirements.

Among the "direct" requirements we include all those where the consumer uses directly, within the limits of his home, any one of the energy sources mentioned previously.

Among the "indirect" requirements we include all those energy consumptions which are generated in the socio-economic system as a result of the production of goods and services which the user may require, since in modern life there is practically no product or service which does not require some energy consumption before reaching the final consumer.

As always, there is an interphase between these two fields. It occurs, for example, with the passenger (and possibly freight) transport system which can be considered a non-energy service as such, but which does have an energy input (public passenger and freight transportation) or contrariwise, a "direct" consumption when this need to travel is met by the user himself with his own private vehicle which may consume (automobile, motorcycle) or not (bicycle) one of the previously mentioned energy sources.

This aspect is particularly important since it should first be defined whether travelling by means of a vehicle which consumes any of these sources is or is not a human being's basic need and this evidently depends on a profusion of factors which we shall not analyze here.

Although we have brought up the subject, our definition of "direct" energy requirements does not include the possible transport needs since this evidently does not come "within the limits of the home".

Another way to identify these two types of requirements would be to call the "direct" ones individual or family needs and the "indirect" ones social needs.The sum of both would make up the total or national requirements of energy per inhabitant.

This division should not be confused with the classic distinction between final and intermediate demand, since final demand should include government consumption and exportations as well as personal consumption. In addition, as regards transport, individual transport should be included in that of the final demand.

Before beginning to analyze in detail each of these categories, we would like to comment on other factors which affect the quantification of the needs or basic energy requirements in both cases.

On the one hand these factors refer to the multiplicity of sources with which energy requirements can be satisfied and on the other, to the diversity of appliances used for the consumption of energy.

The generally accepted methodology for preparing energy balances establishes three basic levels in which an energy consumption can be measured:

a) gross energy
b) net energy
c) useful energy

The profusion of sources and the wide variety of appliances affects the passing from one level to another since the respective yields are different.

Evidently it is possible to define a level of useful energy such that the satisfaction of a specific need (e.g. lighting, cooking) requires an amount of useful energy independently of the source or appliance by which it is met. In this sense it would appear interesting to define the basic energy requirements at the level of useful energy. This is relatively simple if done by means of a normative-type process.

Conversely, if it is desired to refer to the existing statistical information regarding real energy consumptions, it is only possible to work at the level of net or gross energy, in which case the former level is preferable to the latter.

There is yet another difficulty, however, which is that to meet a specified need there are processes or technologies which, even at the level of useful energy, require different quantities of energy (e.g. cooking with a common boiling pan or with a pressure cooker, making cement by the dry or the wet process).

Another problem which has no easy solution refers to the useful energy necessary for space conditioning and which varies for a given climatic region according to the design and the materials of the dwelling. At all events, even in the passive solar systems there is a specific energy contribution. In the case of isolating materials, a flow of direct energy is being substituted by an indirect energy content incorporated into these materials.

Over and above this last difficulty, the passage from useful energy to net energy implies defining the type of source used for meeting a specified need and the type of appliance in which this source is used. Moreover, the distribution, losses and consumptions of these energy sources up to the end consumer must be included.

In turn, the passing from net to gross energy requires definition of the type of source used and the transformation processes or technologies used for reaching the level of net energy. In this case it will also be necessary to include the transformation, transport and production losses of each of the energy sources considered.

3. Analysis of the different needs.

3.1. "Direct" needs.

Among the "direct" needs, individual or family, as we have called them, we can distinguish two fundamental classes: a) those which cover specifically energy needs and b) those which are derived from other needs.

a) Specific needs.

We consider that the energy required for space conditioning (heating or cooling) and for lighting would come exclusively within this category.

In both cases the energy is used to cover a deficit (or surplus) in environmental conditions normally provided by Nature and in both cases the requirement can be zero, at least during specific periods of the year.

- Lighting.

This requirement arises from the moment a rhythm of human activities is accepted or assumed which attempts to be independent of the daily cycles of availability of natural light.

This availability is variable according to the latitude in which the user is located and for a given latitude it is variable throughout the year in a cyclical, foreseeable manner. In addition, in all cases meteorological conditions affect the availability of natural light quite unpredictably.

If we take a cycle of human activities divided into 8 hours rest, 8 hours work and 8 hours of other activities, we can assume that during 16 hours a day it will be necessary to have natural and/or artificial light.

Only in extreme latitudes and only during certain periods of the year can it be assumed that the natural light will cover total requirements. In other words, in most cases a complement of artificial lighting will be necessary which, in annual average values, will vary basically with the latitude.

Furthermore, this requirement will vary with the type of activity which it is desired to carry out during the periods of artificial lighting, with the size of the house and with the level of lighting desired.

Once a certain requirement of lighting is defined, it will be necessary to define the type of appliance and the energy source to be used in order to estimate the quantity of energy required for meeting it at the level of useful and net energy.

- Space conditioning.

If we start from the fact that for a person to reach optimum yield and/or comfort within an established range of ambient temperatures (which in part depend on other climatological variables such as humidity, pressure, etc.) a certain amount of energy to supply the necessary heat (or cold) will be required every time that range is not maintained, either upwards or downwards.

This amount of energy will increase as we go further away, either upwards or downwards, from the above-mentioned range.

Here again, the deviations will depend on the geographical location of the user, and in this case not only the latitude is significant but also the height above sea level.

Throughout the year these requirements will vary according to the regular climatic changes provoked by the changing seasons and the irregular changes caused by unpredictable types of weather conditions.

Unlike lighting, there are immense territories where the natural climatic conditions throughout the year maintain the temperature within the desired range (or very close to it). Thus the energy requirement would be zero.

This situation occurs very largely in the developing countries.

It would be appropriate to point out here that this energy requirement is connected with and depends to some extent on the degree of satisfaction of other basic needs such as clothing and housing.

Adequate clothing and a house designed to insulate the inside from the external climatic variations may enable the range of temperatures to be amplified, in the first case internal and in the second external, in which the energy need continues to be zero.

This situation, which we shall see occurring again in other aspects, raises the doubt as to whether basic needs coefficients can be defined for each of them independently, or whether it is necessary to define an interrelated, coherent combination.

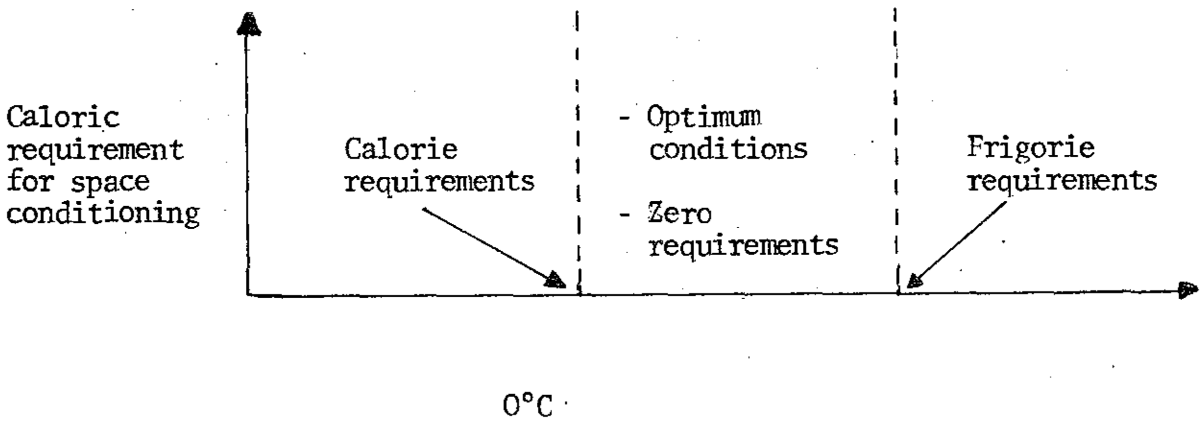
Even taking the foregoing into account, it is evident that there is a large proportion of the world's population which requires varying quantities of energy for space conditioning.

The type of energy necessary, the suitable appliances for that type and the sources which can supply it, will depend in part on the direction in which natural conditions deviate from the optimum range.

As a result of the location of the developed countries in zones in which the downward deviations predominate, this point is normally dealt with under the heading "heating" but it should be borne in mind that in the majority of the developing countries it is more in the nature of "refrigeration".

It is also for this reason that there exists a cultural bias about how "basic" the need for "refrigeration" may be in comparison with "heating" for equivalent deviations in temperature with respect to the ideal range mentioned above. It is evident that technological complexity also influences this evaluation and the cost of supplying "frigories" compared to the supply of equivalent "calories."

Since this aspect of the basic energy needs can vary from zero up to representing the most important portion of the "direct" requirements, we consider it advisable to consider it independently and to make estimates for several average climatic conditions which enable the variation of the requirement to be visualized with the variation of those conditions, taking into account a certain level of quality (isolation) of the housing and the kind of clothing used.



Variation in the energy requirements for space conditioning in function of the climatic conditions.

b) Derived requirements.

The remaining "direct" energy requirements really depend on the satisfaction of another type of need.

Thus, the requirements of energy for cooking and the preservation of food are connected with the satisfaction of the need for food, mainly as regards its quality.

The requirements for heating water, drying and ironing are related with the family unit's needs of personal cleanliness, the washing of clothes and dishes.

The requirements for pumping water, both in rural and urban environments, are related to the need for its supply in adequate conditions in order to meet the individual's sanitary and health needs.

- Cooking and preservation of food.

While the definitions of basic needs as regards food only specify a quantity of calories and proteins per inhabitant without specifying the type or degree of preparation to which they should be submitted, it is well known that the majority of meals require a certain amount of energy for their preparation. It is appropriate to point out here that for a large part of the population in developing countries the energy applied to food constitutes the main, if not the only, component of the total energy consumption.

This energy requirement varies in part with the climatic conditions but to a lesser extent than the needs for lighting and space conditioning mentioned above.

It is reasonable to suppose, since there is very little exact information on the subject, that the energy requirement connected with food varies fundamentally according to cultural traditions and the type of food available, which in turn determine the type and frequency of the meals to be prepared.

Nevertheless, and unlike the requirement for space conditioning, the variations around an average value are of less importance and references are found in the literature regarding the necessary level in different countries.

In connection with the requirements for the preservation of food, a distinction should be made between the developed countries (mostly with temperate or cold climates) and the developing countries (mostly with hot climates). For the former, these requirements could be considered as less important than those for cooking, but for the latter we consider they are of similar importance since the preservation of food is prior to its preparation and the lack of adequate means generates a heavy loss of food resources in those countries.

- Personal cleanliness.

This need, which is not often mentioned, depends to a great extent on cultural and historical customs which in turn may have been generated by climatic conditions and by the degree to which the needs of availability of water and energy were historically satisfied.

Under this heading we include the heating of water, ironing and drying. The energy requirements to cover the first and the last point depend greatly on the climatic conditions and in many cases they may be zero although evidently the efficiency with which clothes and dishes are washed increases with the temperature of the water used for the purpose.

As regards ironing, it may appear strange to include it among basic needs but wide experience with rural electrification shows that one of the first appliances and at times the only one introduced, except for lighting, when electricity is available is the smoothing iron.

It would be necessary, however, to investigate, particularly in suburban or marginally urban areas, to what extent this appliance is an article of personal consumption or whether it belongs to an activity producing services (ironing for other persons).

Of these headings mentioned here, obviously the heating of water is the most important.

- Recreation and social communication.

We consider it very important to take into account this type of need to avoid falling into purely materialistic patterns or the mere biological subsistence of human beings.

In addition this type of need is intimately connected with the satisfaction of needs for education and participation.

Furthermore, recent experience in marginal areas, especially in the urban sector, shows the high priority which this type of energy consumption has compared to others which "rationally" could be considered more important.

From an exclusively energy viewpoint, and bearing in mind the very latest electronic technologies, the requirement in absolute terms is not important compared to those mentioned earlier but it does demand the availability of a particular energy source - and one of high quality - this being electricity.

In this case consumption will depend on the type of appliance used and the frequency with which it is used, which in turn depends on the free time of the members of the familiar group and of the quality or "attraction" of the programs which can be provided.

The frequent use of "batteries" as an energy source means that this expenditure should be included within the energy budget and not under other headings.

- Pumping of water.

This requirement also occurs in the interphase between the "direct" and the "indirect" requirements, since in the urban sectors it should be considered a service, and therefore indirect. This is normally the case and when there is an additional household-type energy requirement it is due to deficiencies in the public service.

In rural areas, however, where the corresponding public service does not exist, it becomes a "direct" type requirement, although very often it is confused with the requirement for production type activities which, in that case, is an indirect requirement.

The amount of energy requirement connected with the supply of water to the house for personal consumption is very variable depending on the conditions under which it is feasible to obtain water in each specific location. In many cases it is extracted by means of head pumps, therefore requiring inanimate energy.

3.2. "Indirect" needs.

By "indirect" energy needs we refer to all the energy demands of the socio-economic system in question which are different from the "direct" ones.

In some work carried out recently the methodology used leads implicitly to another definition of the "indirect" needs since normally the starting point is a family budget (whether for a specific income level or for the whole range) and the direct and indirect energy content of each of its components is estimated.

This method, although interesting in itself, leaves out the energy consumptions connected with governmental activities which do not have a specific price (unless the tax burden is considered) and with the exports which constitute the other two components of the final demand.

Since governmental activities also satisfy population needs and since exports are the necessary counterpart of imports, we consider that the energy input of both activities should also be included in the analysis.

Finally, we should consider the gross national investment whose energy input corresponds in part to the "input" in equipment or amortization of the existing production capital and therefore in a correct calculation of the energy content of the final products it should already have been taken into account. It also includes, however, the energy input necessary for the expansion of the system which should also be given consideration.

To summarize, we understand by "indirect" needs the energy inputs of all the production activities of the socio-economic system, both products and services, and whether they are intended for consumption, exports or investment.

To define this type of requirement a series of theoretical and practical problems arises.

The practical problems will be posed on analyzing the calculation methodology in the next point.

The theoretical problems are connected in their more general aspect to what have been called "development styles".

It is evident that the energy intensity of the various "development styles" is different in quantity and quality, for which reason the resulting production structure is different.

These "development styles" will in part be conditioned by the set of natural resources available and therefore this structure of available resources predetermines, to a certain extent, the energy intensity of the system.

In addition, if we are thinking only of the indirect requirements for meeting the "basic needs" it is difficult to imagine a real economic system which only seeks this objective. Normally other needs are also satisfied at least for a part of the total population.

Even when a specific "development style" has been determined, there still remains a second class of indetermination which is that referring to the type of technology to be used in each of the production processes since a biunial correspondence does not exist between "development style" and technology.

The problem of technology has repercussions in the energy input of the system on the one hand according to how intensive it is in energy, and on the other hand according to its efficiency for transforming net energy into useful energy.

In connection with the energy input of the transportation sector, it is partially determined by the geographical features of the territory (extension, relief), in which the socio-economic system in question is located, but it is also greatly influenced by the decisions of the system as regards the regional distribution of the population and the characteristics of the urban system already developed or to be developed. In all cases, the resulting energy consumption on being measured in gross energy or primary energy will also depend on the structure by energy supply source, due to the different yields and energy consumptions of each of the primary energy sources.

In this case also, the climate has a certain influence but we consider that percentagewise it is less than that mentioned for some direct consumptions which depend almost exclusively on climatic factors.

4. Quantification methodologies

Once the specific characteristics of the "direct" and "indirect" energy needs have been analyzed, we shall attempt to suggest in this point some methodologies for their quantification which should be applied definitely to each particular system, since we have seen that it is very difficult to determine a single or average value which takes into account the numerous possible circumstances.

It is obvious that these quantifications are only approximate estimates and do not attempt to provide exact or invariable values.

4.1. "Direct" needs.

It is under this heading that possibly the greatest differences occur in the results but contrariwise it would appear that the methodology can be the same and moreover relatively easy to state (though maybe not to put into practice).

In the end it is a question of calculating a family "energy budget" considering individually each of the "direct" needs mentioned in the previous point.

In order to be able to compare the results, although they are different, it will first be necessary to define what would be the needs to include in the budget because they are of a basic type, independently of whether they are present to a greater or lesser degree in each particular case.

In this sense, and as a proposal for their analysis and discussion we consider that they should include the following, by order of priority:

- Preparation and preservation of food and supply of water.
- Space conditioning.
- Lighting.
- Personal cleanliness.
- Recreation and social communication.

For each of these a level of "quality" or minimum degree of satisfaction should be established.

Once the above has been defined we believe it advisable to estimate, on the basis of the characteristics of the location and the level of satisfaction of other needs (clothing, housing, food, education, health) the requirements at a useful energy level and only after transforming those values to the values of net and gross energy on the basis of an established level of technology and an established structure by sources of energy supply.

For each system under analysis we consider it advisable to carry out separate estimates for the rural and urban areas.

4.2. "Indirect" needs.

In this case the definition of a calculation methodology appears to be much more complex and difficult if it is really desired to obtain significant and comparable values.

One possibility is that of combining the technique of the family budget, including all the goods and services required, with that of the calculation of the energy content of those goods and services.

In this case it will be necessary to define an integral budget which will cover all the basic needs of the family group (and this is an advantage of the methodology) and then proceed to analyze the energy content, direct and indirect, of each component.

As we mentioned before, all the services which the socio-economic system provides should be included in the budget, independently of whether a specific price is or is not paid for them (e.g. the governmental services and others such as street lighting).

When considering the indirect inputs, for their part, those contained in exports and in the net internal investment should be considered in order to take into account the relationship with overseas and with the expansion of the system.

While this may appear to be the ideal methodology we doubt whether it is applicable, with a minimum of certainty in the results, in the majority of the developing countries due to the lack of necessary information for this type of estimate which, in addition, is extremely laborious.

Moreover, to the extent that they are based on historical data, the results will be conditioned both by the "development style" and by the technologies and processes used in the period to which the data correspond.

One interesting possibility would be given by the preparation of a sufficiently detailed and flexible model which would permit simulating the operation of the system according to various "development styles" and using various alternative technologies and processes.

In the event of having a model with such characteristics, it would be possible either to simulate alternative scenarios or attempt to optimize the system using the energy consumption as the objective function to be minimized.

Of course, such a model requires an accumulation of data which is normally difficult to obtain in developing countries.

Another approach which appears interesting because of the simplicity of its application is that which has recently begun to be developed 3) and which attempts to relate total consumption of primary energy with an index of quality of life (see Graph N° A9-1).

In the estimates carried out a discontinuity or change of slope appears in the resulting function which would enable the minimum level of total energy requirements ("direct" and "indirect") to be defined.

Evidently this methodology requires further analysis and refining to obtain unobjectionable results and in this sense we shall point out here some lines of research.

- Improvement in the estimate of the quality of life index.

Some critics of this methodology indicate that the saturation which occurs in the evolution of the index is due, to a great extent, to its very characteristics since the components of the index have by definition a maximum limit (life expectancy, literacy, etc.).

In addition, it is argued that the variables used for constructing the index are not suitable for measuring the evolution of "quality of life" beyond certain levels which could coincide with the point of discontinuity observed.

While these objections are partially acceptable, it can also be argued that if certain adequate variables are incorporated into the index it is possible that it would descend to the very high levels of energy consumption which correspond to that of urban areas of the most developed countries, where the quality of life is not necessarily better than in areas with a lower energy consumption.

At all events, we consider that it is feasible, with the information presently

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3) Ph. Palmedo, R. Nathans et al. Op. cit.

available, to substantially improve the independent variable of this model, i.e. the quality of life index.

- Improvements to the energy data

Here various different courses of action are possible:

a) To improve the estimate of non-commercial energy consumption instead of adopting a uniform "floor" which only manages to displace the location of the axis of the ordinates.

b) To eliminate, by means of a separate analysis, the differences in consumption caused by climatic factors, or to work exclusively with data from countries whose climatic conditions are similar. This climatic component should be added a posteriori as a function, for example, of the annual average temperature or another suitable indicator.

c) To eliminate by a separate analysis, the "direct" consumptions calculated independently, in order to determine autonomously the "indirect" component.

d) To use as energy data the consumptions expressed in useful energy or at least in net or secondary energy, instead of using the data in gross or primary energy.

e) To include in the whole not only the developing countries but also the developed ones in order to detect the behavior of the function at very high levels of energy input.

Evidently, each of the refinements proposed complicates the methodology and reduces its possibilities of application to the developing countries. Nevertheless, with the reservations expressed previously, we consider that this methodology is more applicable and interesting than the first one.

5. Quantification exercise

5.1. "Direct" needs.

On the basis of the information recapitulated and prepared for this work we shall proceed to develop a series of estimates of the "direct" basic energy needs.

The values calculated should be considered only as a first approximate estimate and not as exact or invariable values.

As pointed out in the methodology, we shall consider three typical climatic conditions: hot, temperate and cold; and for each of them we shall make the analysis for a rural and an urban area.

In order to give a quantitative value also to the different degrees of priority which exist in the satisfaction of these needs, we shall divide the estimate into three levels.

Level 1 corresponds to the total satisfaction of those first-priority, specific or derived needs, or partial satisfaction in the case of lower-priority ones.

Levels 2 and 3 are considered additional needs which, together with those of level 1, constitute a total value with which the basic needs are estimated to be completely satisfied at a level such that they permit the suitable personal development of every inhabitant in the climatic conditions specified.

In addition, the proposed values assume implicitly that the other basic needs are also satisfied adequately, such as food, housing and clothing, so that in no case is the energy used to compensate a lower degree of satisfaction of any of these needs.

a) Hot Zone - Rural Area.

i) With a little less than 30 Koe/person/year of useful energy and 227 Koe/p/year of primary energy, the minimum basic needs would be satisfied which in Tables A9-1 to A9-6 have been included in Level 1 and represent 50% and 80% respectively of the total needs.

These values imply covering uses such as lighting, food preservation, water pumping, water heating, ironing and recreation which are unknown to and/or do not satisfy a large part of the rural inhabitants of the hot zones of Latin America, mainly due to their condition of extreme poverty. A more decorous and desirable level of these needs would be reached with 50 Koe/p/year of useful energy and 312 Koe/p/year of primary energy, by means of the introduction of artificial space ventilation (fans), a refrigerator suitable for the size of the family for longer preservation of food, greater use of hot water for personal hygiene, cleanliness of the house, dishes and clothes, as well as access to a means of recreation and potentially of formation, such as television.

Here the shared use of some appliances, such as communal refrigerators, ironing and washing facilities and television, has not been assumed. If some or many cultural patterns could be overcome and, moreover, if the suitability of such facilities for raising the presently very low living conditions of these inhabitants could be demonstrated, the consumption coefficients per inhabitant referred to would certainly decrease.

ii) In principle, access to electrical energy appears to be a minimum basic need, which does not necessarily imply a rural electrification network using systems derived from large-scale generation and which often mean high costs of investment in transmission and transformation. There is the possibility of integrating energy systems in rural villages where the electrical energy could be generated from agrarian and human wastes, covering at the same time caloric energy needs.

If, however, for various reasons it were not possible to have electrical energy, it has been assumed that the minimum basic needs could be satisfied by means of using liquid and/or gaseous fuels (kerosene, liquefied gas, biogas) both for lighting and for food preservation and ironing; by using windmills for water pumping and solid state batteries for recreation and social communication.

Table A9-2 shows that the rural populations with electrical energy could satisfy minimum basic needs with 224 Koe/p/year of primary energy and the population that have no electricity with 227 Koe/p/year of primary energy, the difference arising from the lower yield of kerosene lamps for lighting compared to electric lamps.

iii) The largest part of energy consumption measured in useful energy, almost 76%, is applied to cooking and preparing food and to water heating. The other uses of some quantitative relevance are the preservation of food (19%) and recreation (8%). Thus the remaining 3% is used for space cooling, ironing, lighting and water pumping.

iv) The fuels expressed in primary energy would represent 75% of consumption and electrical energy the remaining 25%.

v) Electricity consumption per inhabitant would be some 212 Kwh/year which represents a monthly family consumption of approximately 110 Kwh. The distribution of this consumption by type of use can be seen in Table N° A9-2, with almost 40% devoted to food preservation and 25% to recreation.

vi) As regards the other forms of energy necessary per family and per day, on the basis of the yields indicated in the references mentioned in Tables A9-1 to A9-6, they would be the following:

Firewood	9 kilograms (for cooking)
Kerosene	1.0 liter (for hot water)
	9.5 liters (for lighting, ironing and hot water in Level 1).
Liquefied gas	0.25 kgs (for refrigerator in Level 1)
Batteries	6 1.5-V batteries per month
1 Windmill	driving a 0.03 Kw pump

b) Temperate Zone - rural area.

i) With 41 Koe/p/year of useful energy and 340 Koe/p/year of primary energy the minimum basic needs indicated in Level 1 of Tables A9-3 and A9-4 would be met. These values are 45% and 57% respectively of the total needs.

ii) The rural villages with electrical energy available will be able to meet minimum basic needs with 336 Koe/p/year of primary energy and those without electricity with 340 Koe/p/year of primary energy.

iii) The main uses, expressed in useful energy, are those intended for space heating, cooking of food and water heating, which take up 89% of the energy. The preservation of food and recreation absorb about 9% and lighting, space cooling, ironing and water pumping the remaining 2%.

iv) The fuels expressed in primary energy represent 88% of the consumption and electricity the other 12%.

v) The consumption of electricity per inhabitant and per year would reach 190 Kwh, i.e. about 95 Kwh per family per month. The preservation of food would take 33%, recreation 29%, and lighting 27% of the total of electrical consumption. The remaining 11% would be devoted to the other uses which can be seen in Table A9-4.

vi) The other forms of energy necessary per family per day would be as follows:

Firewood:	21 kilograms (for cooking and heating)
Kerosene:	2.0 liters (for heating water)
	0.9 liter (for lighting, hot water and ironing at Level 1)
Liquefied gas:	0.2 kg (for refrigerators in Level 1)
Batteries:	6 1.5 V batteries per month
1 Windmill:	driving an o.03 Kw pump.

c) <u>Cold zone - rural area.</u>

i) With 56 Koe/p/year of useful energy and 470 Koe/p/year of primary energy, the minimum basic needs would be covered, indicated in Level 1 of Tables A9-5 and A9-6. These requirements are 33% and 38% respectively of the total needs.

ii) The villages which are served with electrical energy would cover their minimum basic needs with 471 Koe/p/year in primary energy and those without the service with 470 Koe/p/year.

iii) Space heating represents 45% of the total energy consumption, followed by water heating with 35% and the cooking of food with 16%. The remaining 4% are used for recreation, lighting, ironing and water pumping.

iv) 95% of consumption is supplied by fuels and 4% by electrical energy.

v) The consumption of electricity, as can be seen in Table A9-6, would reach 144 Kwh/p/year, which is equivalent to 72 Kwh per family per month. Recreation with 50% and lighting with 40% are the two most outstanding uses. The remaining 10% is used for ironing clothes (9%) and water pumping (1%).

vi) The other forms of energy necessary per family per day would be the following:

Firewood:	51 kg (for heating and cooking)
Kerosene:	3.3 liters (for hot water)
	0.5 liters (for lighting and ironing)
Batteries	6 1.5V batteries per month
1 Windmill	driving a pump equivalent to 0.03 Kw

d) Comparison between the different climatic zones.

On comparing the consumption structures for the three zones observing Tables A9-1 to A9-6, the following are the most important comments:

i) As temperature increases, i.e. when going from the cold zones to the hot ones (as they were defined in this example) requirements decrease for heating (disappearing in the hot zones), hot water, recreation, lighting and cooking. The reasons are obvious for the first two uses. As regards recreation, it was assumed that the more intensive use of radio and television would be to a certain extent related to the fewer inducements offered by the lower temperatures to leave the house during resting periods, and for lighting, due to the shorter duration of daylight. In the case of cooking food, it has been assumed that the type of food in the hot zones may comprise meals which incorporate a greater quantity of uncooked fruit and/or vegetables than is the case in the temperate and cold zones.

ii) Conversely, as temperature increases, the consumption of electrical energy devoted to space conditioning (fans), the preservation of food (refrigerators) increases and larger volumes of water are required, involving more energy for pumping.

iii) The ironing of clothes would require similar energy consumption for the three climatic zones. Although in the hot zones clothes may become dirtier, it is also true that fewer clothes are worn.

iv) In all the cases: cooking, heating and water heating taken together exceed three-quarters of the energy requirements.

v) Graphs A9-2 and A9-3 are sufficiently clear as regards appreciation of the above comments.

e) Urban area - Hot zone.

It can be seen from Table A9-7 that the minimum basic needs, expressed in useful energy would in this case require 34 Koe/p/year and the total 54 Koe/p/year.

Out of this total, the cooking of food and its preservation represent 50%, next in importance being needs corresponding to personal cleanliness with 40%, the remaining 10% being distributed between needs of recreation, lighting and space conditioning.

Table A9-8 gives the respective values in primary energy, assuming the use of electricity and liquefied gas as energy vectors.

The minimum basic needs require a total of 118 Koe/p/year of which half is supplied by fuels and the other half by electricity. Total basic needs reach 200 Koe/p/year. Of this total, 42.5% is used for cooking and food preservation, 20% for personal cleanliness, 20% for lighting, 12.5% for recreation and social communication and only 5% for refrigeration.

The different consumption structure according to whether the analysis is made in primary or useful energy, arises from the different yields estimated in each of the various uses.

It is also interesting to note that the specifically mechanical and/or electrical needs which are supplied with electricity represent a total consumption of 361 Kwh/p/year, of which lighting and food preservation represent the most important consumptions with 31% each, next in importance being consumption for recreation and social communication, which represent 19.2%. The remaining 19% is distributed between personal cleanliness and space cooling.

As regards this last requirement, it should be pointed out that evidently the energy values indicated do not permit the need for heating in the temperate and cold zones to be "satisfied".

This subject would require a deeper conceptual analysis and a more detailed quantitative analysis in order to define the basic needs for both requirements in an equivalent manner. The values given here only attempt to reflect the satisfaction levels which are normally encountered in each case.

f) Urban areas - Temperate zone.

In this case the minimum requirements for covering basic needs reach 51.2 Koe/

p/year expressed in useful energy and the total requirements 109.5 Koe/p/year (see Table A9-9).

In the total requirements the most important item becomes personal cleanliness with 38.4%, followed by space heating with 27.3% and preservation and cooking of food with 26.4%. Recreation, lighting and space cooling represent the remaining 8%.

If instead of analyzing the structure on the basis of consumption in useful energy it is done in its equivalent in primary energy, it will be seen that out of the total requirements those corresponding to preservation and cooking of food are the most important with 28.8%, followed by personal cleanliness with 23.7%, heating representing 20.3% and lighting 17%.

The remaining 10% is distributed between refrigeration and recreation and social communication (see Table A9-10).

If the specifically mechanical or electrical requirements which are assumed to be supplied by electricity are considered independently, it will be seen that they would require a total of 343 Kwh/p/year, of which 43.7% corresponds to lighting, 21.9% to food preservation and 20.4% to recreation and social communication, distributing the remaining 15% between space cooling and personal cleanliness.

g) Urban area - cold zone.

According to the values presented in Table A9-11 we see that the minimum and total requirements increase substantially, reaching 95.8 Koe/p/year and 113 Koe/p/year respectively, expressed in useful energy.

This increase is due basically to the larger requirements for space heating, this item occupying first place with about 53.5% of the total, followed by personal cleanliness with 27.7%. Food cooking and preservation lose importance and only represent 13.4%, the remaining 5% being for lighting and recreation.

As regards requirements expressed in primary energy, it will be seen in Table A9-12 that they reach 241 Koe/p/year and 535 Koe/p/year to cover the minimum and total values respectively.

In the total values for this zone, heating continues to be the most important item (44.8%) followed by personal cleanliness (18.7%) with lighting and food cooking at a similar level of around 14%. As in the other cases, the requirements for recreation and social communication are the lowest.

Finally if the consumptions supplied by electricity are analyzed, it is seen that they will require a total of 386 Kwh/p/year, of which 62% corresponds to lighting and 29% to recreation and social communication.

In this sense it should be pointed out that the satisfaction of this last basic need, so important for allowing the personal development of each individual, in general accounts for a very low percentage of the total requirements but it requires energy of high quality, such as electricity, representing an important percentage of the electrical requirements.

h) Comparison between the different climatic zones (urban area).

In Graphs A9-4 and A9-5 the total requirements have been summarized for each zone in useful energy and in primary energy.

In the first case it will be seen that the requirements in useful energy increase by 90% in the temperate zone and 286% in the cold one in comparison with the hot zone.

This difference is fundamentally provoked by the requirements for space heating and for water heating, whose increases are not compensated by the reduction in requirements corresponding to refrigeration and food preservation.

As regards primary energy, the increase is not so important (47.5% and 167%) for the temperate and cold zones due to the fact that the yields between useful and primary energy of the two uses indicated above are the highest (40.5% and 67.5%).

Moreover, the requirements of a mechanical and/or electrical type practically do not vary and compensations are produced between the increase in lighting and recreation and the decrease in refrigeration and food preservation.

Finally, it could be remarked that specific needs, particularly heating, rather than derived needs, are those which increase as the temperature decreases.

i) Comparison between the rural and urban areas.

If Graphs A9-2 and 3 and A9-4 and 5 are analyzed it will be found that in all cases the requirements in useful energy corresponding to the urban area are higher than those of the rural area in each zone.

It is important to note that this difference is not very high (it does not exceed 32%) but it does show substantial and opposing differences when the requirements are considered at the level of primary energy, since in the case of the cold zone, the rural area requirements would be 136% higher than those of the urban area. This is due exclusively to the low yield of the energy sources normally used in the rural area, in particular in the case of firewood.

It is for this reason we consider that these types of definitions and analyses should be carried out in terms of useful energy and not at primary energy level since in the latter case it is necessary to introduce an additional variable into the estimate, this being the supply structure of these requirements, which is very variable and independent of them.

5.2. Total needs (direct and indirect)

All of the methodologies indicated in the previous point for the determination of "indirect" needs require work which is beyond the scope of this study, for which reason we shall limit ourselves to some comments on the basis of the total needs estimates worked out in the paper by Palmedo-Nathans et al. (1978) quoted above. (Graph No. A9-1).

We can see there that approximately at the level of 800 Koe/inhabitant there is a change in tendency of the function, a value of approximately 80% corresponding to it in the quality of life index.

We could therefore consider this value to be the minimum total energy requirement for reaching a reasonable quality of life index.

If we compare these values with the real Latin American situation around 1975, we find that while the whole region would have been approximately at that level, there were 16 countries with a population of 200 million which were still below the basic level.

The above-mentioned authors also point out, on the basis of various bibliographic sources, that the subsistence consumption would be around 200 to 260 Koe/inhabitant.

The facts demonstrate that in Latin America there is at least one country which is at this level and that there are another six which do not exceed 400 Koe/inhabitant.

This might suggest that the subsistence level, at least in hot countries, may be below the values indicated by the above-mentioned authors.

Bearing in mind the problem of the substantial difference in yield between the commercial and the non-commercial sources, the situation at the useful energy level is even more serious since, on general lines, the countries or regions where total consumption is lower are also those in which the participation of the non-commercial sources is greater.

If it is assumed conservatively that the average yield of the commercial sources is 40% and the non-commercial sources 10%, we would have the situation that the basic needs level (800 Koe/inhabitant in primary energy) would be equivalent to 240 Koe/inhabitant at the level of useful energy with an average yield of 30%.

For the country with the lowest energy consumption in the region, in which the non-commercial energy forms represent 90% of the total, the resulting value would be only 30 Koe/inhabitant, i.e. only 12.5% of the basic level, a very much lower value than the 29% resulting from the same comparison carried out at the level of primary energy. Considering that several countries of Latin America are at consumption levels per inhabitant of between 300 and 400 Koe/inhabitant measured in primary energy and that in those countries the non-commercial sources represent about 50% of the total, the result would be that the useful consumption would vary between 60 and 80 Koe/inhabitant, which is only 25 to 30% of the basic values defined previously.

Once again, to complete this analysis, it must be emphasized that all these values are national averages in which the consumptions of the medium and higher levels of the population have a substantial influence, and therefore the consumption of the lower levels which make up the majority of the population, are most certainly in all cases far below the percentages mentioned.

5.3. "Indirect" needs.

As was mentioned in point 4.2, one way of determining the indirect needs would be to find the difference between the value specified for the total needs (point 5.2) and the direct needs (point 5.1).

For this it would be necessary that the function which relates the quality of life index with the total energy consumption be determined with data corresponding to countries and regions with similar climates in order to be able to compare these results with each of the zones analyzed in the case of the direct needs.

Even so, it would be necessary to make a more profound conceptual analysis to clarify whether both measurements correspond to a similar level of satisfaction of basic needs or not.

Finally the comparison should be carried out on the basis of the data expressed in useful energy, since otherwise the supply structure corresponding to each measurement might totally distort the results.

For all these reasons, we consider that the values presented in points 5.1 and 5.2 cannot be compared the one with the other and therefore we cannot determine, within the framework of this paper, the "indirect" basic needs.

6. Conclusions.

We consider that this paper has contributed to a better conceptual definition of basic energy needs, providing a basis for subsequent analyses and critiques of the subject.

The possible methodologies for developing a quantitative estimate of the needs has been suggested and a concrete estimate for six typical situations in relation to the "direct" basic needs has been presented.

We hope that in the future it will be possible to broaden and deepen the study of this subject, as its importance demands.

TABLE A9-1

ESTIMATE OF THE DIRECT BASIC ENERGY NEEDS
Rural Area
Useful energy
(Koe/p/year)

I. Hot climate zone (average annual temperature 25°C)

Use \ Level	1	2	3	total	references
Lighting	0.4	0.2	-	0.6	(1)
Heating	-	-	-	-	(2)
Space cooling	-	-	1.3	1.3	(3)
Subtotal	0.4	0.2	1.3	1.9	
Food preservation	3.2	2.1	-	5.3	(4)
Cooking	18.0	-	-	18.0	(5)
Water pumping	0.3	-	-	0.3	(6)
Hot water	4.0	9.0	7.0	20.0	(7)
Ironing clothes	0.3	0.3	-	0.6	(8)
Recreation and communication	1.1	2.1	0.8	4.0	(9)
Subtotal	26.8	13.5	7.8	48.2	
TOTAL	27.2	13.7	9.1	50.0	

Source: Fundación Bariloche, own calculation, see references on pages 31-33

TABLE A9-2

ESTIMATE OF DIRECT BASIC ENERGY NEEDS
Rural Area - Primary energy (Koe/p/year)

I. Hot climate zone (annual average temperature 25°C)

	1 (*)						2			3			Total (*)			
	Without electric.			With electricity			With electricity			With electricity			With electricity			Ref
	Comb.	E.E.	Tot.	Comb.	E.E.	Tot.	Comb.	E.E.	Tot.	Comb.	E.E.	Tot.	Comb.	E.E.	Tot.	
Lighting	15,5	(+) -	15,5	-	(26) 9,7	9,7	-	(15) 5,6	5,6	-	-	-	-	(41) 15,3	15,3	(1)
Heating	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(2)
Space cooling	-	-	-	-	-	-	-	-	-	-	(18) 6,7	6,7	-	(18) 6,7	6,7	(3)
Subtotal	15,5	-	15,5	-	(26) 9,7	9,7	-	(15) 5,6	5,6	-	(18) 6,7	6,7	-	(59) 22,0	22,0	
Food Preservation	16,0	-	16,0	-	(49) 18,3	18,3	-	(34) 13,0	13,0	-	-	-	-	(83) 31,3	31,3	(4)
Cooking	176,0	-	176,0	176,0	-	176,0	-	-	-	-	-	-	176,0	-	176,0	(5)
Water pumping	-	1,7	1,7		(4,6) 1,7	1,7	-	-	-	-	-	-	-	(4,6) 1,7	1,7	(6)
Hot water	11,0	-	11,0	11,0	-	11,0	26,0	-	26,0	20,0	-	20,0	57,0	-	57,0	(7)
Ironing clothes	1,2	-	1,2	-	(5) 1,9	1,9	-	(5) 1,9	1,9	-	-	-	-	(10) 3,7	3,7	(8)
Recreation and communication	-	5,6	5,6	-	(15) 5,6	5,6	-	(29) 10,8	10,8	-	(11) 4,1	4,1	-	(55) 20,5	20,5	(9)
Subtotal	204,2	7,3	211,5	187,0	(73,6) 27,5	214,5	26,0	(68) 25,7	51,7	20,0	(11) 4,1	24,1	233,0	(152,6) 57,2	290,2	
TOTAL	219,7	7,3	227,0	187,0	(99,6) 37,0	224,0	26,0	(83) 31,0	57,0	20,0	(29) 11,0	31,0	233,0	(211,6) 79,0	312,0	

Source: Fundación Bariloche, own calculation. See references on pages 31-33.

(*) The minimum level can be satisfied alternatively either with electricity and fuels or only with fuels, mechanical energy and solid state batteries. The first case is headed: with electricity and the second: without electricity.

(+) This column includes mechanical energy for pumping water (e.g. by windmills) and solid state batteries for transistorized radios.

( ) Values given in parenthesis correspond to ($\frac{\text{Kwh}}{\text{inhabitants/year}}$)

TABLE A9-3

ESTIMATE OF THE DIRECT BASIC ENERGY NEEDS
Rural Area
Useful energy
(Koe/p/year)

II. Temperate climate zone (average annual temperature 18°C)

Use \ Level	1	2	3	Total	References
Lighting	0.5	0.3	-	0.8	(1)
Heating	6.7	6.7	6.9	20.3	(2)
Space cooling	-	-	0.5	0.5	(3)
Subtotal	7.2	7.0	7.4	21.6	
Food preservation	2.4	1.6	-	4.0	(4)
Cooking	21.6	-	-	21.6	(5)
Water pumping	0.3	-	-	0.3	(6)
Hot water	8.0	17.0	13.0	38.0	(7)
Ironing clothes	0.3	0.3	-	0.6	(8)
Recreation and communication	1.1	2.1	0.8	4.0	(9)
Subtotal	33.6	21.0	13.8	68.4	
TOTAL	40.8	28.0	21.2	90.0	

Source: Fundación Bariloche, own calculation, see references on pages 31-33.

TABLE A9-4

ESTIMATE OF THE DIRECT BASIC ENERGY NEEDS
Rural Area - Primary Energy
(Koe/p/year)

II. Temperate climate zone (average annual temperature 18°C).

Use	1 (*) Without electr. Comb.	E.E.	Tot.	1 (*) With electricity Comb.	E.E.	Tot.	2 With electricity Comb.	E.E.	Tot.	3 With electricity Comb.	E.E.	Tot.	Total (*) With electricity Comb.	E.E.	Tot.	Ref.
Lighting	19,4	(+) -	19,4	-	(33) 12,2	12,2	-	(18) 6,8	6,8	-	-	-	-	(51) 19	19	(1)
Heating	67,0	-	67,0	67,0	-	67,0	67,0	-	67,0	69,0	-	69,0	203,0	-	203,0	(2)
Space cooling	-	-	-	-	-	-	-	-	-	-	(7) 2,7	2,7	-	(7) 2,7	2,7	(3)
Sub-total	86,4	-	86,4	67,0	(33) 12,2	79,2	67,0	(18) 6,8	73,8	69,0	(7) 2,7	71,7	203,0	(58) 21,7	224,7	
Food preservation	12,0	-	12,0	-	(37) 13,8	13,8	-	(25) 10	10	-	-	-	-	(62) 23,8	23,8	(4)
Cooking	211,0	-	211,0	211,0	-	211,0	-	-	-	-	-	-	211,0	-	211,0	(5)
Water pumping	-	1,3	1,3	-	(3,5) 1,3	1,3	-	-	-	-	-	-	-	(3,5) 1,3	1,3	(6)
Ironing clothes	23,0	-	23,0	23,0	-	23,0	49,0	-	49,0	37,0	-	37,0	109,0	-	109,0	(7)
Recreation and communication	1,2	-	1,2	-	(5) 1,9	1,9	-	(5) 1,9	1,9	-	-	-	-	(10) 3,8	3,8	(8)
Sub-total	-	5,6	5,6	-	(15) 5,6	5,6	-	(29) 10,8	10,8	-	(11) 4,1	4,1	-	(55) 20,5	20,5	(9)
TOTAL	247,2	6,9	254,1	234,0	(60,5) 22,6	256,6	49,0	(59) 22,7	71,7	37,0	(11) 4,1	41,1	320,0	(130,5) 49,4	369,4	
	333,6	6,9	340,5	301,0	(93,5) 34,7	335,7	116,0	(77) 29,5	145,5	106,0	(18) 6,8	112,8	523,0	(188,5) 71,0	594,0	

Source: Fundación Bariloche. See references on pages 31-33
Notes: (*) See hot zone - (+)See hot zone - ( ) See hot zone.

TABLE A9-5

ESTIMATE OF THE DIRECT BASIC ENERGY NEEDS
Rural Area
Useful energy
(Koe/p/year)

III. Cold climate zone (average annual temperature 10°C)

Level / Use	1	2	3	Total	References
Lighting	0.6	0.4	-	1.0	(1)
Heating	15.0	31.0	30.0	76.0	(2)
Space cooling	-	-	-	-	(3)
Subtotal	15.6	31.4	30.0	77.0	
Food preservation	-	-	-	-	(4)
Cooking	27.0	-	-	27.0	(5)
Water pumping	0.2	-	-	0.2	(6)
Hot water	12.0	27.0	21.0	60.0	(7)
Ironing clothes	0.3	0.3	-	0.6	(8)
Recreation and communication	1.3	3.2	0.8	5.3	(9)
Subtotal	40.7	30.5	21.8	93.1	
TOTAL	56.3	61.9	51.8	170.0	

Source: Fundación Bariloche, own calculation, see references on pages 31-33.

TABLE A9-6

ESTIMATE OF THE DIRECT BASIC ENERGY NEEDS
Rural Area - Primary Energy
(Koe/p/year)

III. Cold Climate Zone (Average annual temperature 10°C)

Use	1(*)						2			3			Total (*)			Ref
	Without electric.			With electricity			With electricity			With electricity			With electricity			
	Comb.	E.E.	Tot.	Comb.	E.E.	Tot.	Comb.	E.E.	Tot.	Comb.	E.E.	Tot.	Comb.	E.E.	Tot.	
Lighting	22,0	(+) -	22,0	-	(37) 13,6	13,6	-	(22) 8,4	8,4	-	-	-	-	(59) 22,0	22,0	(1)
Heating	150,0	-	150,0	150,0	-	150,0	310,0	-	310,0	300,0	-	300,0	760,0	-	760,0	(2)
Space cooling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(3)
Sub-total	172,0	-	172,0	150,0	(37) 13,6	163,6	310,0	(22) 8,4	318,4	300,0	-	300,0	760,0	(59) 22,0	782,0	
Food preservation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(4)
Cooking	264,0	-	264,0	264,0	-	264,0	-	-	-	-	-	-	264,0	-	264,0	(5)
Water pumping	-	0,9	0,9	-	(2,3) 0,9	0,9	-	-	-	-	-	-	-	(2,3) 0,9	0,9	(6)
Hot water	34,0	-	34,0	34,0	-	34,0	77,0	-	77,0	60,0	-	60,0	171,0	-	171,0	(7)
Ironing clothes	1,2	-	1,2	-	(5) 1,9	1,9	-	(5) 1,9	1,9	-	-	-	-	(10) 3,8	3,8	(8)
Recreation and communication	-	6,7	6,7	-	(18) 6,7	6,7	-	(44) 16,4	16,4	-	(11) 4,1	4,1	-	(73) 27,2	27,2	(9)
Sub-total	299,2	7,6	306,8	298,0	(25,3) 9,5	307,5	77,0	(49) 18,3	95,3	60,0	(11) 4,1	64,1	435,0	(85,3) 31,9	466,9	
TOTAL	471,2	7,6	478,8	448,0	(62,3 23,2	471,2	387,0	(71) 26,7	413,7	360,0	(11) 4,1	364,1	1195,0	(144,3) 54,0	1249,0	

Source: Fundación Bariloche, own calculation. See references on page 31-33
Notes: (*) See hot zone - (+) See hot zone - ( ) See hot zone.

REFERENCES: Table Nos. A9-1 to A9-6.

The above mentioned Tables include the values calculated for useful energy and primary energy.

The rural family considered comprises six persons, at least two of whom are adults.

It has been assumed that the level of minimum inanimate energy needs (level 1) can be satisfied in two ways. One excludes electrical energy, so that lighting, food preservation, water pumping, ironing of clothes and recreation (radio) are covered by means of fuels, mechanical energy (windmills) and solid state batteries.

The other way assumes that the population received electrical energy.

It must be clarified that consideration has not been given to other types of energy, such as direct natural solar energy for drying crops or human energy for pumping water.

(1) Lighting.

A family unit comprising three bedrooms, kitchen-dining room and bathroom has been assumed. The installed power varies between 180 W for level 1 and 380 W for levels 2 and 3. The load factors for the different zones and levels are given below:

Zone \ Level	1	2	3
Hot	0.10	0.07	0.07
Temperate	0.12	0.09	0.09
Cold	0.14	0.11	0.11

The conversion of electrical energy to useful energy was carried out using 860 Kcal/Kwh and a yield of 20%. To obtain the equivalent primary energy the value of 4000 Kcal/Kwh was adopted, assuming small generator sets and/or rural networks.

For the alternative of lighting by kerosene gas lamps, a consumption of 650 Kcal per 100 candelpower/hour was assumed, a yield of 3% and three 100 candle-power lamps each.

(2) Heating.

This energy use was excluded from the hot zones.

i) Temperate zones: Heating is used 120 days/year, 8 hours per day. As fuel, firewood was adopted with a yield of 10%, which implies appliances where combustion is carried out in a closed hearth with natural draft by means of a stack.

ii) Cold zones: Heating is used 270 days per year between 4 and 8 hours a day according to the level, using firewood as in the above case.

(3) Space cooling.

It is assumed that the cold zones do not require energy for this purpose. In the hot and temperate zones for level 3, a 1/15 HP fan operating 2160 hours/year and 800 hours/year respectively was included.

The yield adopted is 90%.

(4) Food preservation.

This includes cold preservation (refrigerators). Drying and preserves manufacture are not analyzed here.

Two cases are analyzed, according to whether or not electrical energy is available.

If electricity is available, the standard refrigerator is assumed to be 7.7. cu. ft. with a 170W motor for level 2 and a 100W motor for level 1. In the hot zones 2920 hours/year of use are estimated and 2190 hours/year in the temperate zones.

The yield used is 80%.

For the case of fuel-operated refrigerators, liquefied gas with a consumption for level 1 of 350 Kcal/hour was assumed, a 20% yield and the same hours of use as for electrical appliances.

(5) Cooking.

The coefficients used were obtained from polling rural inhabitants and employers, simulating consumption for 2 daily meals, breakfast, snack, roast meat and the preparation of oil and preserves. The fuel adopted is firewood in cookers with 10% yield.

(6) Water pumping

It was estimated that according to whether hot, temperate or cold zones were involved, the daily consumption of the rural family would vary between 2000, 1500 and 1000 liters respectively.

(7) Hot water

The coefficients arise from the analysis made on projecting the domestic consumptions for the rural sector, on the basis of assuming the following consumptions for the hot zone:

Level 1 .... 6 liters/person/day
Level 2 .... 20 liters/p/day
Level 3 .... 30 liters/p/day

The temperature of the hot water was estimated at 45°C.

For the temperate and cold zones the conjunction of larger thermal increases and larger consumptions per person and per day are reflected in energy input coefficients two and three times greater respectively than those corresponding to the hot zone.

The fuel used is kerosene with a yield of 35%.

(8) Ironing clothes.

A standard 500 W iron was adopted with 120 hours/year use for levels 2 and 3 and 60 hours/year for level 1. Yield was estimated at 70%.

For the kerosene gas iron, a yield of 25% was assumed.

(9) Recreation and social communication.

The appliances it was estimated would be necessary for this were radio and television.

In the first level only a radio used 4 hours/day in the hot and temperate zones and 5 hours/day in the cold zones.

At levels 2 and 3 television is incorporated at 2 hours/day in the hot and temperate zones and 3 hours/day in the cold zones.

In all cases, it was assumed that the radio is transistorized, consuming batteries equivalent to 60W power.

The television set was estimated to have a capacity of 240 W.

TABLE A9-7

ESTIMATE OF DIRECT BASIC ENERGY NEEDS
Urban Area
Useful energy in Koe/p/year

I. Hot climate zone (average annual temperature 25°C).

Uses / Priorities	1	2	3	Total	References
1. Specific needs					
a) Lighting	1.0	1.0	-	2.0	(1)
b) Space heating	-	-	-	-	(2)
c) Space cooling	-	-	2.0	2.0	(3)
Subtotal	1.0	1.0	2.0	4.0	
2. Derived needs					
a) Food preservation	5.0	2.0	-	7.0	(4)
b) Cooking of food	20.0	0	0	20.0	(5)
c) Personal cleanliness					
- Hot water	5.0	10.0	5.0	20.0	(6)
- Ironing	1.0	1.0	-	2.0	(7)
d) Recreation and social communication	2.0	2.0	1.0	5.0	(8)
Subtotal	33.0	15.0	6.0	54.0	
TOTAL	34.0	16.0	8.0	58.0	

Source: Fundación Bariloche, own calculation.

REFERENCES (Table A9-7).

(1) Corresponds to a capacity of 50 w/p functioning on an average of 3.5 hours/day with an estimated yield of 20% at user level.

(2) In view of the average annual temperature it is considered that in this zone the need is zero.

(3) Corresponds to fans which consume a total of 0.075 Kwh/day/person.

(4) Corresponds to a 1/4 HP refrigerator - 0.18 Kw, functioning 18 hours/day for an average family of 5 persons, with a yield of 0.8.

(5) Estimate of the useful energy requirements necessary for cooking on the basis of real data on net energy used and yield.

(6) Estimate of the requirements of useful energy required for heating water on the basis of data from polling and specific consumptions.

(7) Corresponds to a 1 Kw iron functioning half-an-hour per day on the average for a family of 5 persons, with a yield of 0.7.

(8) Corresponds to a 0.1 Kw radio functioning 5 hours per day and a 0.25 Kw television set operating 2 hours per day, or other similar combination equivalent to a consumption of 1 Kwh/day/family, for a family of 5 persons, with a yield of 0.9.

TABLE A9-8

ESTIMATE OF THE DIRECT BASIC ENERGY NEEDS
Urban Area
Primary energy in Koe/p/year

I. Hot climate zone (average annual temperature 25°C)

Uses / Priority	1	2	3	Total	References
1. Specific needs					
a) Lighting	20 (60)	20 (60)	-	40 (120)	(1)
b) Space heating	-	-	-	-	
c) Space cooling	-	-	10 (27)	10 (27)	(2)
Subtotal	20 (60)	20 (60)	10 (27)	50 (147)	
2. Derived needs					
a) Food preservation	25 (80)	10 (30)	-	35 (110)	(3)
b) Cooking of food	50	-	-	50	(4)
c) Personal cleanliness					
- Hot water	8	15	7	30	(5)
- Ironing clothes	5 (17)	5 (17)	-	10 (34)	(6)
d) Recreation and social communication	10 (28)	10 (28)	5 (14)	25 (70)	(7)
Subtotal	98 (125)	40 (75)	12 (14)	150 (214	
TOTAL	118 (185)	60 (135)	22 (41)	200 (361)	
Caloric	58	15	7	80	(8)
Electric	60 (185)	45 (135)	15 (41)	120 (361)	(9)

Source: Fundación Bariloche, own calculation on basis of Table A9-7.

Note: The values in parenthesis ( ) correspond to the consumptions in Kwh/p/year measured at user level in net energy with the equivalent of 860 cal/Kwh, when the respective need is met with electricity.

REFERENCES. (Table A9-8).

(1) It is assumed to be supplied with electricity with a yield of 0.2 in the user level and 0.25 in distribution and production of thermal origin or equivalent electricity.

(2) It is assumed to be supplied with electricity with a yield of 0.9 at user level and 0.25 in the distribution and production of electricity.

(3) It is assumed to be supplied with electricity with a yield of 0.8 at user level and 0.25 in the distribution and production of electricity.

(4) It is assumed to be supplied with liquefied petroleum oil gas with a yield of 0.45 at user level and 0.9 in distribution and production.

(5) It is assumed to be supplied with liquefied petroleum gas with a yield of 0.75 at user level and 0.90 in the distribution and production.

(6) It is assumed to be supplied with electricity with a yield of 0.70 at user level and 0.25 in distribution and production.

(7) It is assumed to be supplied with electricity with a yield of 0.9 at user level and 0.25 in distribution and production.

(8) Corresponds to uses 2a and 2c (hot water).

(9) Corresponds to uses 1a, 2a, 2c (ironing) and d.

TABLE A9-9

ESTIMATE OF DIRECT BASIC ENERGY NEEDS
Urban Area
Useful energy in Koe/p/year

II. Temperate climate zone (average annual temperature 18°C).

Uses \ Priorities	1	2	3	Total	References
1. Specific needs					
a) Lighting	1.2	1.3	-	2.5	(1)
b) Space heating	5.0	10.0	15.0	30.0	(2)
c) Space cooling	-	-	1.0	1.0	(3)
Subtotal	6.2	11.3	16.0	33.5	
2. Derived needs					
a) Food preservation	3.0	2.0	-	5.0	(4)
b) Cooking of food	24.0	-	-	24.0	(5)
c) Personal cleanliness					
- Hot water	15.0	15.0	10.0	40.0	(6)
- Ironing clothes	1.0	1.0	-	2.0	(7)
d) Recreation and social communication	2.0	2.0	1.0	5.0	(8)
Subtotal	45.0	20.0	11.0	76.0	
TOTAL	51.2	31.3	27.0	109.5	

Source: Fundación Bariloche, own calculation.

REFERENCES (Table A9-9).

(1) Corresponds to a capacity of 50 w/p functioning on the average 4.5 hours/day with an estimated yield of 20% at user level.

(2) Estimate of useful energy requirement necessary for space heating on the basis of data from polls and specific consumptions of the respective areas.

(3) Corresponds to fans which consume a total of 0.040 Kwh/day/person.

(4) Corresponds to a 0.18 Kw refrigerator functioning 6 hours/day for an average family of 5 persons with a yield of 0.80.

(5) Estimate of useful energy requirements necessary for cooking on the basis of real data of net energy used and typical yields.

(6) Ditto for hot water.

(7) Corresponds to a 1 Kw iron functioning half-an-hour per day on the average for a family of 5 persons with a yield of 0.7.

(8) Corresponds to a 0.1 Kw radio functioning 5 hours per day and a 0.25 Kw television set functioning 2 hours per day, or another similar combination equivalent to a consumption of 1 Kwh/day/family, for a family of 5 persons with a yield of 0.9.

TABLE A9-10

ESTIMATE OF DIRECT BASIC ENERGY NEEDS
Urban area
Primary energy in Koe/p/year

II. Temperate climate zone (average annual temperature 18°C)

Priorities / Uses	1	2	3	Total
1. Specific needs				
a) Lighting	24 (72)	26 (78)	-	50 (150)
b) Space heating	10 -	20 -	30 -	60 -
c) Space cooling	-	-	5 (14)	5 (14)
Subtotal	34 (72)	46 (78)	35 (14)	115 (164)
2. Derived needs				
a) Food preservation	15 (45)	10 (30)	-	25 (75)
b) Cooking of food	60 -	-	-	60 -
c) Personal cleanliness				
- Hot water	23 -	22 -	15 -	60 -
- Ironing	5 (17)	5 (17)	-	10 (34)
d) Recreation and social communication	10 (28)	10 (28)	5 (14)	25 (70)
Subtotal	113 (90)	47 (75)	20 (14)	180 (179)
TOTAL	147 (162)	93 (153)	55 (28)	295 (343)
Caloric	93 -	42 -	45 -	180 -
Electric	54 (162)	51 (153)	10 (28)	115 (343)

Source: Fundación Bariloche, own calculation.

Notes: 1. The values in parentheses ( ) correspond to the consumptions in Kwh/p/year measured at user level in net energy with the equivalent of 860 cal/Kwh, when the respective need is met with eléctricity.
2. For conversion yields to primary energy, see notes to Table A9-8.
3. For heating, a yield of 0.45 is assumed at user level and 0.90 for distribution and production of liquefied petroleum oil gas.

TABLE A9-11.

ESTIMATE OF DIRECT BASIC ENERGY NEEDS
Urban Area.
Useful energy in Koe/h/year.

III. Cold climate zone (average annual temperature 10°C)

Uses / Priorities	1	2	3	Total	Ref.
1. Specific needs					
a) Lighting	1.8	2.2	-	4.0	(1)
b) Space heating	40.0	40.0	40.0	120.0	(2)
c) Space cooling	-	-	-	-	(3)
Subtotal	41.8	42.2	40.0	124.0	
2. Derived needs					
a) Food preservation	-	-	-	-	(4)
b) Cooking of food	30.0	-	-	30.0	(5)
c) Personal cleanliness					
- Hot water	20.0	20.0	20.0	60.0	(6)
- Ironing clothes	1.0	1.0	-	2.0	(7)
d) Recreation and social communication	3.0	3.0	2.0	8.0	(8)
Subtotal	54.0	24.0	22.0	100.0	
TOTAL	95.8	66.2	62.0	224.0	

Source: Fundación Bariloche, own calculation.

REFERENCES (Table A9-11)

(1) Corresponds to an installed capacity of 60 w/p functioning on the average 6 hours/day with an estimated yield of 20%.

(2) Estimate of the useful energy requirement necessary for space heating on the basis of poll data and specific consumptions of representative areas.

(3) In view of the climatic characteristics, it is considered that the requirements in this zone is zero.

(4) In view of the average annual temperature of the zone it is considered that food can be adequately preserved without priority energy requirements.

(5) Estimate of the useful energy requirement necessary for cooking on the basis of real data on net energy used and typical yields.

(6) Ditto for hot water.

(7) Corresponds to a 1 Kw iron functioning half-an-hour per day on the average, for a family of 5 persons, with a yield of 0.7.

(8) It has been estimated that in this zone the climatic characteristics, the cold and lack of natural light, bring about a greater use of radio and television appliances, for which a consumption equivalent to 1.6 Kwh/day/family has been estimated for a family of 5 persons, with a yield of 0.9.

TABLE A9-12

ESTIMATE OF THE DIRECT BASIC ENERGY NEEDS
Urban Area
Primary energy in Koe/p/year

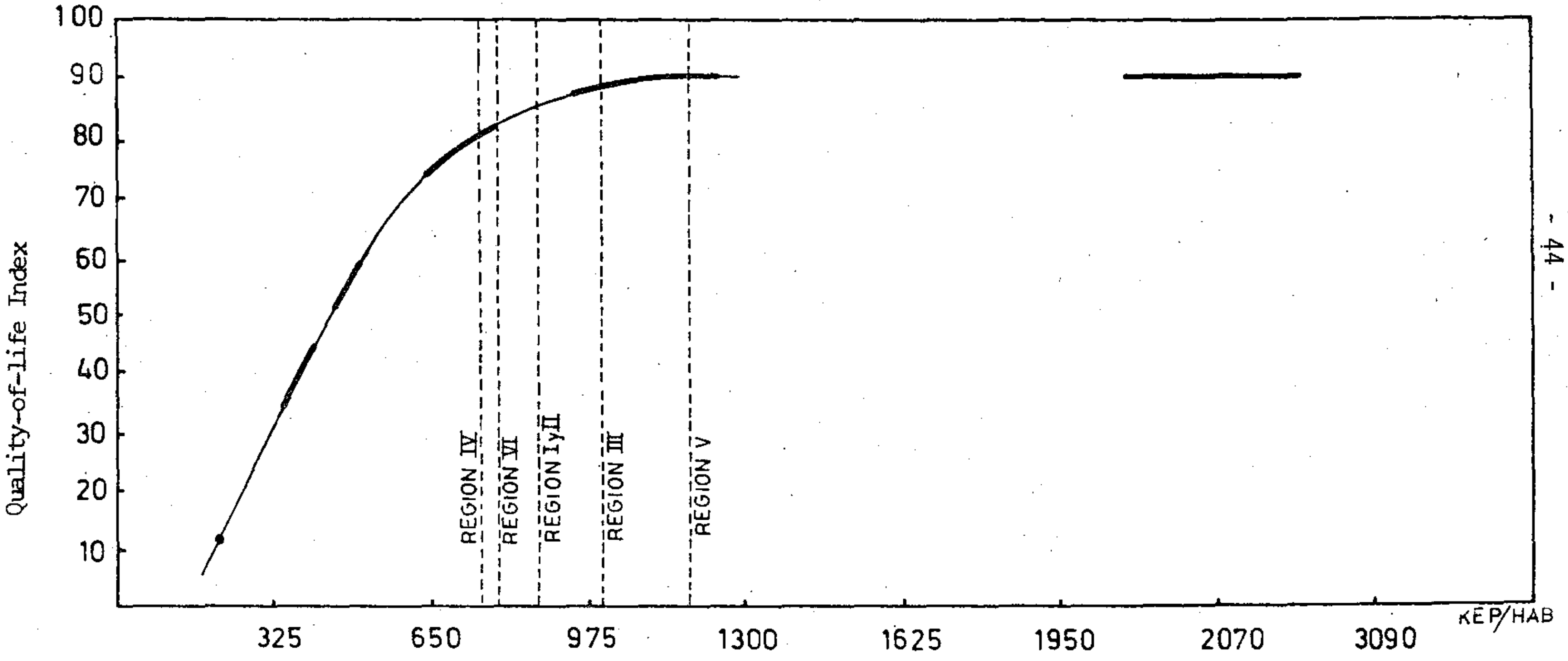
III. Cold climate zone (average annual temperature 10°C).

Uses \ Priorities	1	2	3	Total
1. Specific needs				
a) Lighting	36 (108)	44 (132)	-	80 (240)
b) Space heating	80 -	80 -	80 -	240 -
c) Space cooling	-	-	-	-
Subtotal	116 (108)	124 (132)	80 -	320 (240)
2. Derived needs				
a) Food preservation	-	-	-	-
b) Cooking of food	75	-	-	75
c) Personal cleanliness				
- Hot water	30 -	30 -	30 -	90 -
- Ironing clothes	5 (17)	5 (17)	-	10 (34)
d) Recreation and social communication	15 (42)	15 (42)	10 (28)	40 (112)
Subtotal	125 (59)	50 (59)	40 (28)	215 (146)
TOTAL	241 (167)	174 (191)	120 (28)	535 (386)
Caloric	185 -	110 -	110 -	405 -
Electric	56 (167)	64 (191)	10 (28)	130 (386)

Source: Fundación Bariloche, own calculation on bases of Table A9-11.
Notes: 1. The values in parentheses ( ) correspond to the consumptions in Kwh/p/year measured at user level in net energy with the equivalent of 860 cal/Kwh, when the respective need is met with electricity.
2. For conversion yields to primary energy, see notes to Table A9-8.

RELATION BETWEEN A QUALITY-OF-LIFE INDEX AND ENERGY CONSUMPTION PER INHABITANT

GRAPH A9-1

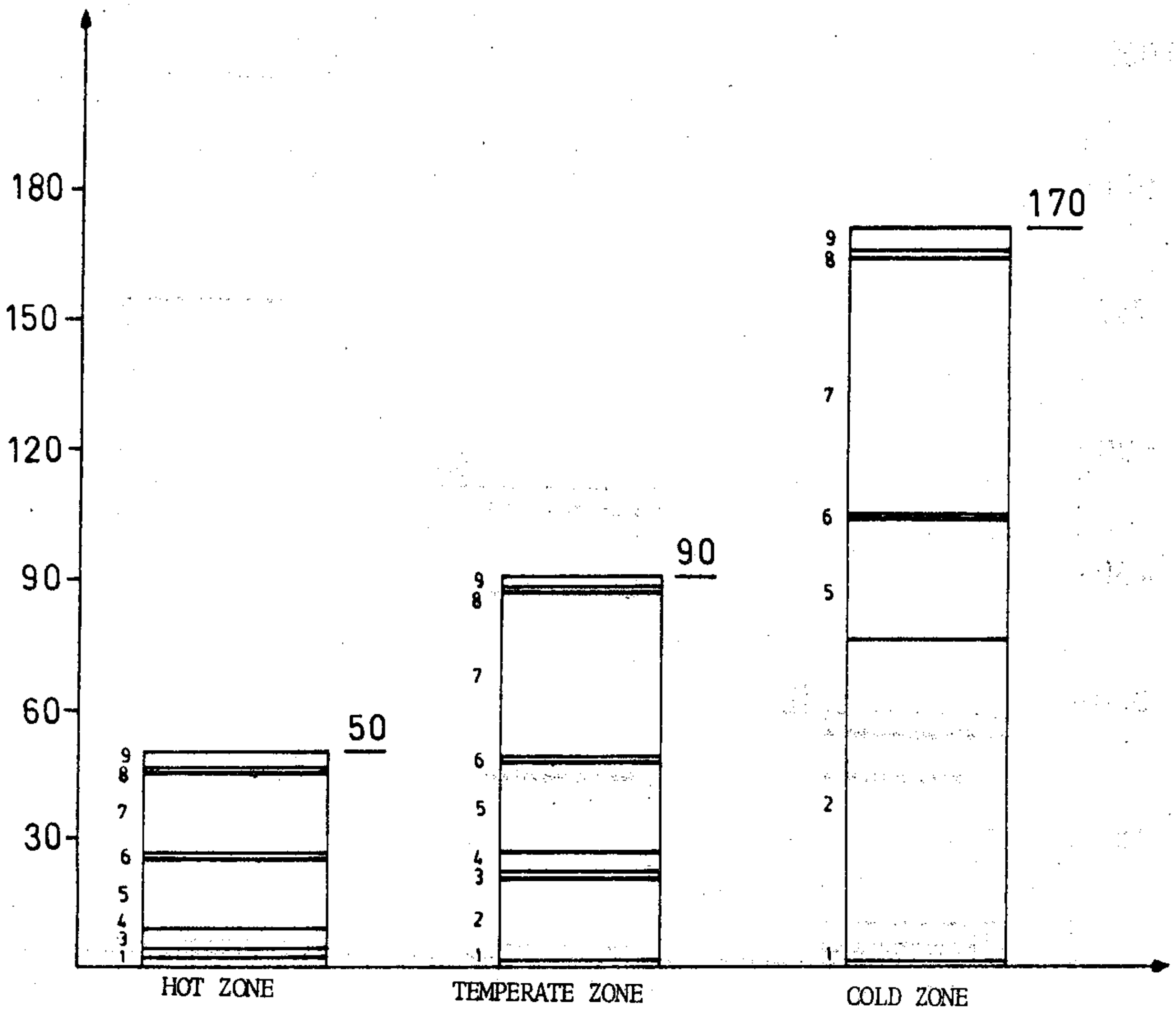


—— Regions in which the Latin American countries are located.

GRAPH A9-2

ESTIMATE OF DIRECT BASIC ENERGY NEEDS
Rural Area - Useful Energy
(koe/inhabitant/year)

1. Lighting
2. Heating
3. Space cooling
4. Preservation of food
5. Cooking
6. Pumping water
7. Hot water
8. Ironing clothes
9. Recreation and communication

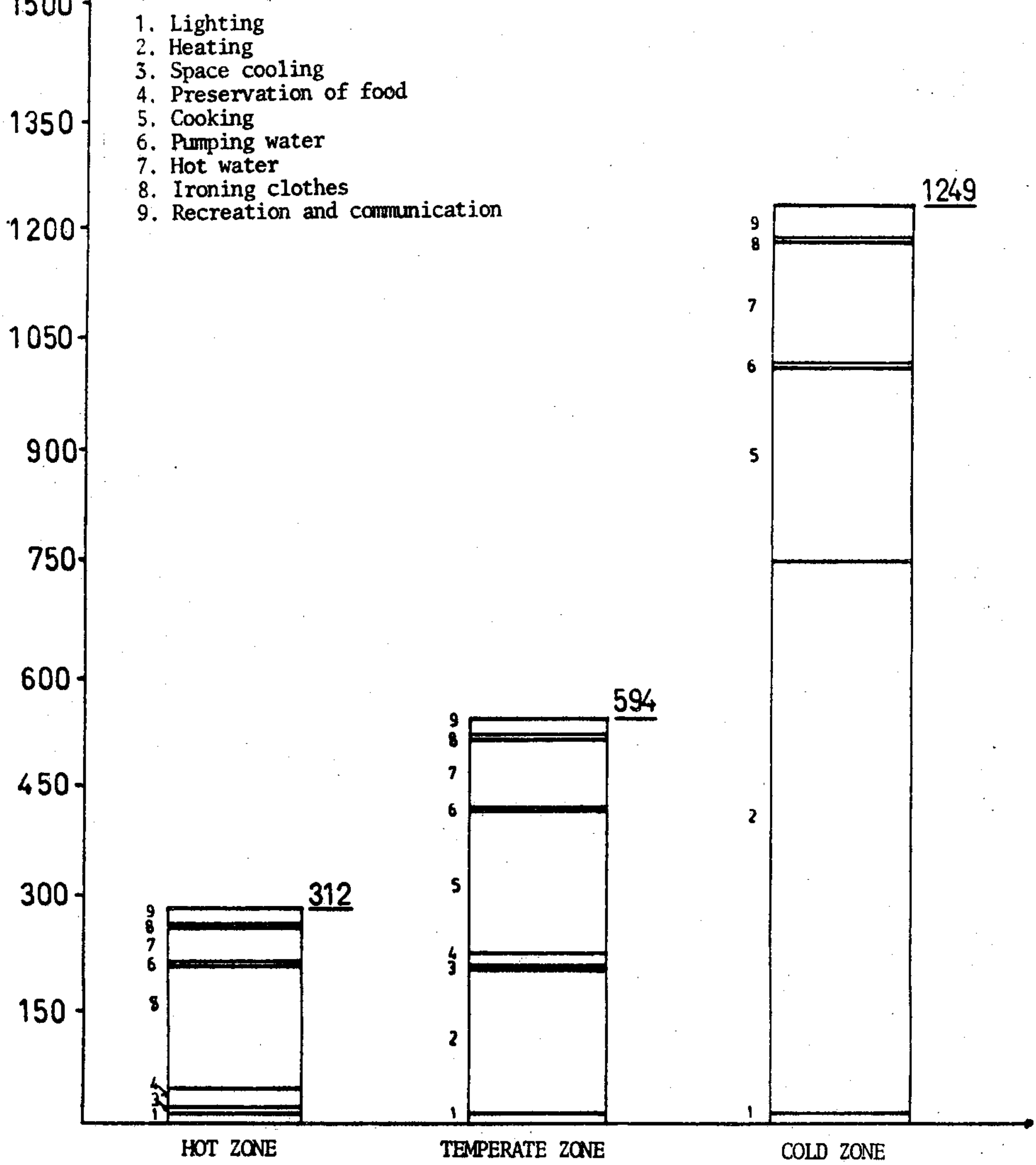


Source: Tables A9-1, 3 and 5

1 cm = 15 $\frac{\text{koe}}{\text{inhab./year}}$

GRAPH A9-3

ESTIMATE OF DIRECT BASIC ENERGY NEEDS
Rural Area - Primary Energy
(koe/inhab./year)

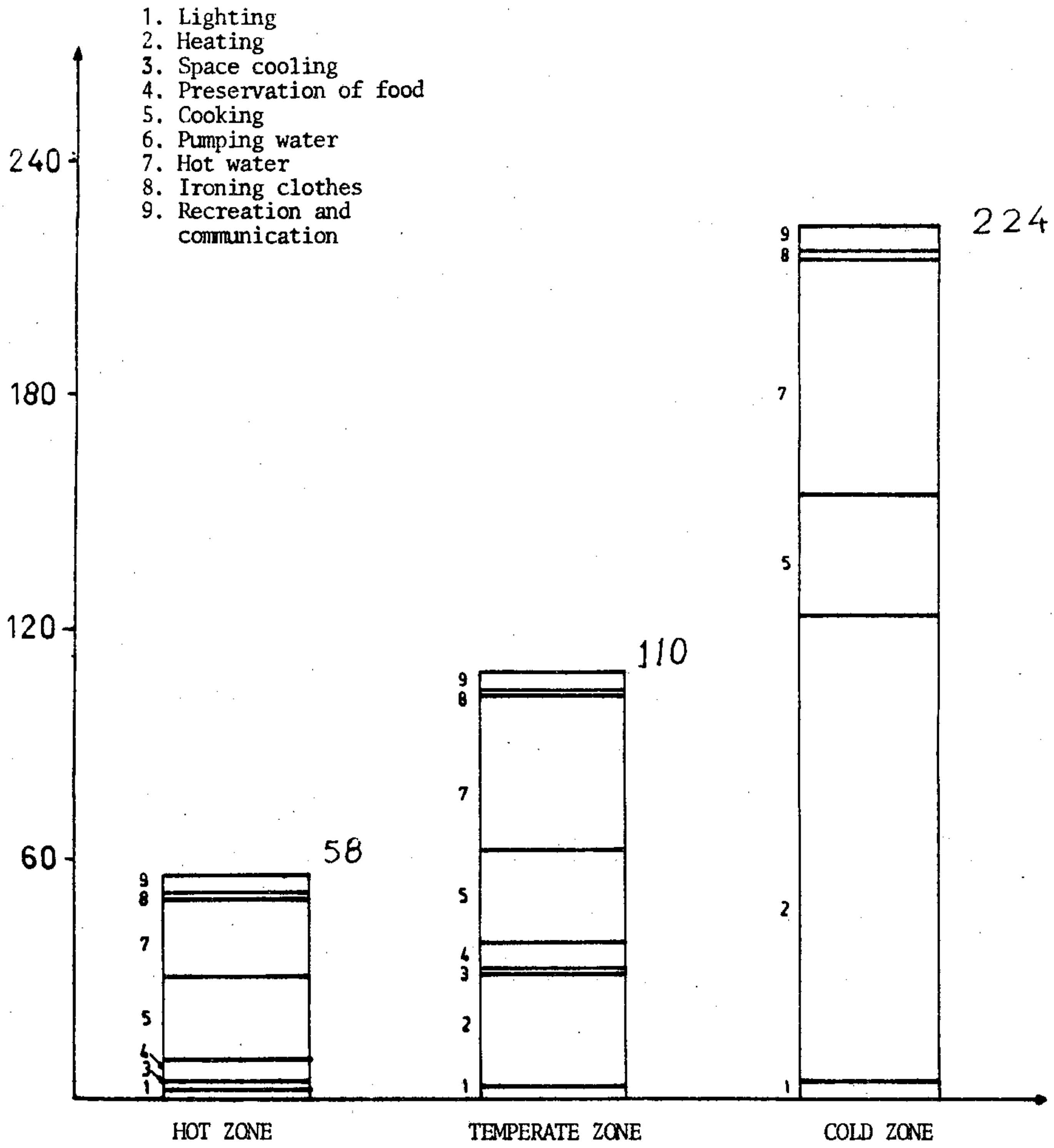


Sources: Tables A9-2, 4 and 6.

1 cm = 75 $\frac{\text{koe}}{\text{inhab./year}}$

GRAPH A9-4

ESTIMATE OF DIRECT BASIC ENERGY NEEDS
Urban Area - Useful Energy
(Koe/inhab./year)



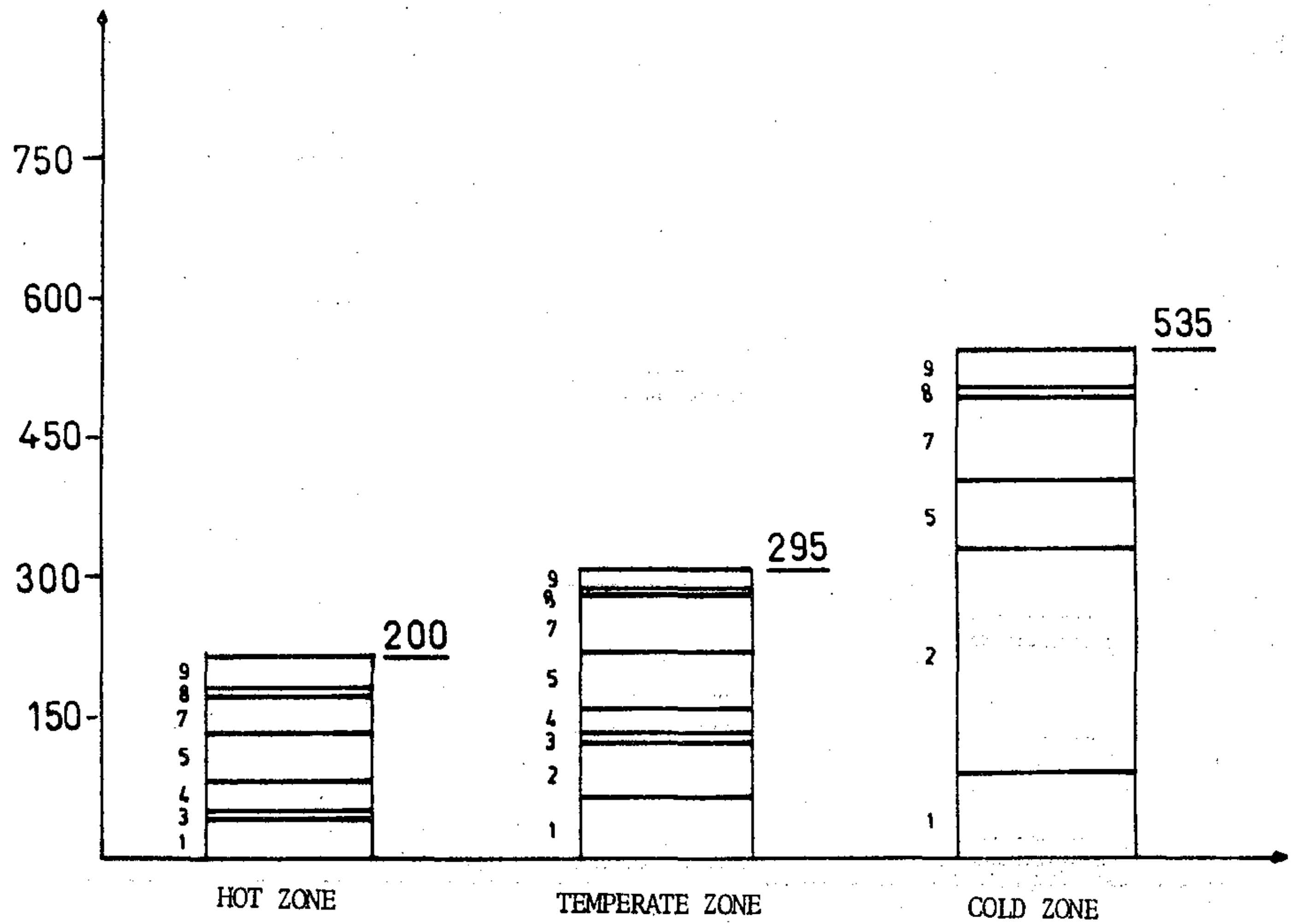
Source: Tables A9-7, 9 and 11.

1 cm = 15 koe/inhab./year

GRAPH A9-5

ESTIMATE OF THE DIRECT BASIC ENERGY NEEDS
Urban Area - Primary Energy
(Koe/inhab./Year)

1. Lighting
2. Heating
3. Space cooling
4. Preservation of food
5. Cooking
6. Pumping water
7. Hot water
8. Ironing clothes
9. Recreation and communication



Source: Tables A9-8, 10 and 12

1 cm = 75 koe/inhab./year

EXHIBIT I

For ease of cummunication with the majority of readers, the more traditional and, until now, widespread concept of needs and basic needs has been used in this paper. Nevertheless, the authors are aware of the new ways of confronting the problem, according to which food, housing, etc., satisfy the needs of Maintenance, Protection, etc.*/

In this context, energy would also satisfy different basic needs.

Thus, for example, the energy necessary for lighting would contribute to a series of personal and extrapersonal needs linked to the categories of Maintenance, Protection, Understanding, Recreation, etc.

The energy required for air conditioning would be directly connected with the Maintenance Need and indirectly to several others (protection, Recreation, etc.).

In the case of cooking and food preservation, the connection with Nutrition and thus with the Maintenance need is direct.

As regards personal cleanliness the connection is more indirect and multiple and it could be said that it connects with the needs of Prevention, Clothing, Physical Habitability, etc.

The energy necessary for pumping water responds in turn to the needs of cooking and personal cleanliness.

All these are basically linked to the needs of "living" at the most general level.

On the other hand, in the case of energy needs for Recreation and Social Communication, they would be more correctly connected to the categories of Participation, Recreation, etc. all of them belonging to the category of "actualization" needs. They also contribute to the need of Understanding within the Living need categories.

In brief, it is a new subject open to more profound research into the energy content of each of the factors and thus of the different needs categories shown in the attached table.

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*/ - See attached table taken from "Quality-of-Life-Oriented Development and Global Social Modelling" by C.A.Mallmann, O. Nudler and M. Max-Neef, 1978.

Classification of needs according to categories of needs \ Classification of needs according to categories of satisfiers which mainly satisfy them.				Personal: A) Psychosomatic or Intra-human	Extra-personal: B) Psychosocial or Inter-human	Extra-personal: C) Psychoecological or Extra-human
		III) Subsistence	I) Maintenance	a) Nutrition, Rest, Exercise,	b) Earning-Work, Reproduction, Social Habitability,	c) Shelter, Clothing, Physical Habitability,
	VI) Existence		II) Protection	a) Prevention, Cure, Defense	b) Prevention, Restitution, Defense,	c) Prevention, Restitution, Defense,
Living		V) Security	IV) Love	a) Belief in oneself, self-love, Identity	b) Friendship, Sexual and Family love,	c) Rooting Attachment,
	XI) Co-existence	VIII) Belongingness	VII) Understanding	a) Psycholization Introspection, Study,	b) Socialization, Education, Information, Observation	c) Habitatization, Observation,
Health		X) Dignity	IX) Participation	a) Liberty, Independence, Autonomy,	b) Autonomous participation in decision,	c) Autonomous participation in management,
	XVI) Growth	XIII) Development	XII) Recreation	a) Self-recreation,	b) Social recreation,	c) Recreation in the habitat
Actualization		XV) Renewal	XIV) Creation	a) Creation by oneself	b) Creation of social environments	c) Creation of habitational environments,
	XXI) Perfection	XVIII) Transcendence	XVII) Meaning	a) Self-realization	b) Historic, Prospective and Religious Meaning	c) Weltanschauung,
		XX) Maturity	XIX) Synergy	a) Authenticity, Equanimity, Security, Humility	b) Solidarity, Justice, Altruism, Generosity, Responsibility	c) Beauty Ecological Equilibrium