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OLADE METHODOLOGY FOR THE
ELABORATION OF ENERGY BALANCES

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1. GENERAL ASPECTS OF THE BALANCE

1.1 Introduction

The situation of uneven development of energy planning instruments which is observed in Latin America led OLADE to propose the execution of the program of Regional Energy Balances to the Tenth Ministers Meeting, held in Panama in December 1979.

The reach and meaning of this program were widely approved; and according to the judgment of the Ministers there assembled, it constitutes an efficacious element for enhancing energy planning, not only in each country, but also in the Latin American area as a whole.

Along these lines, and in order to comply with the mandate expressed in Panama, OLADE presents this document, in which a methodology for the elaboration of energy balances in the Latin American area and the Caribbean is proposed, with the purpose of unifying criteria and also facilitating the work of the authorities and researchers in the energy field, this methodology having been fundamentally developed to be used by the countries of the region and by the region itself, but obviously having possibilities for application at other levels, such as the regional or continental ones.

It is worth noting that the adopted methodology, the consolidated format, and the common unit of aggregation, do not attempt to limit the field of action of the different countries. Indeed, each country is free to adopt a level of breakdown superior to that suggested, or whatever other unit different from that proposed. However, it is desirable to have a minimum common balance for all the Latin American countries, which permits the production of a "consolidated regional balance" and facilitates comparison within the area and with other regions of the world.

The document consists of eight chapters and four appendices. Initially, a summary of the current situation of the Latin American area and the Caribbean is presented, with regard to the elaboration of energy balances. The third and fourth chapters deal with the balance itself, basically the presentation of the global structure, the explanation of the format, definitions terminology, and a guide for their application.

Given that the energy balance requires a good statistical basis for its elaboration, the fifth chapter presents a discussion of the treatment and diagnosis of the information.

Due to the fact that in the region, as opposed to the developed countries, non-commercial energy sources play an important role in energy consumption, the sixth chapter analyzes these and the way to consider their inclusion in the balance.

The seventh chapter discusses the problem of the common unit and the treatment of hydroenergy, geoenergy, firewood, and the calorific power of the solid, liquid, and gaseous fuels.

It is useful to warn that a balance is not an objective in itself, but rather a tool which, in combination with other instruments, will aid in understanding and planning the energy sector within a given socio-economic framework. Consequently, the eighth chapter presents some considerations so that, based on the balance, the results can be analyzed and the basic socio-economic indicators can be calculated, along with other general analyses.

The symbols adopted for each variable component of the balance are set forth in Appendix A; Appendix B shows the treatment of the results from the surveys on non-commercial energy. Appendix C indicates the general treatment of nuclear energy, and finally Appendix D presents the Energy Balances for Ecuador (1978) and Peru (1975) as examples.

1.2 Energy Balance - Definition

The energy balance is a group of equilibrium relationships that numerically expresses the physical flows by which energy is produced, exchanged with the outside, transformed, consumed, etc., all calculated in a common unit, within a given country, and for a given time period (generally, one year).

It is important to present the advantages as well as the limitations of the balance. The balance is a tool that permits global energy planning, but only when considered along with other elements of the economic system. That is to say, taken in isolation, the balance gives an image of the physical relationships of the energy system in a determined historical period. It tells how energy is produced, exported or imported, trans - formed, or consumed by the economic sectors. It permits the calculation of certain efficiency relationships and the formation of a diagnosis for a given country's, region's, or continent's energy situation. Nevertheless, it is by means of its relationship with other socio-economic variables that the ba - lance becomes an instrument for planning. In this sense, an energy balance is a pre-condition for the energy planning models. A balance fulfills a role in the energy sector analagous to that of the imput-product matrices in the economic sector.

In the current state of development of the area's energy balances, these have the limitation of not evaluating the energy reserves and not reaching the stage of useful energy. 1/ Efforts tending to keep an energy accounting from the phase of reserves up to that of useful energy will facilitate policy analysis and formulation, especially in the field of energy substitution.

1/ This is the energy really used in the final energy processes, due to the fact that not all of the energy which enters a consumer system is utilized, and each case depends on the efficiency of the consuming apparatus.

On the other hand, for developing countries, given the importance of the rural sector and of the "non-commercial" sources of energy, it is essential to include the said consumptions in the balance, with the purpose of knowing the energy structure of the rural sector, its problems and implications for the national economy.

1.3 Fundamental Objectives

- To evaluate the dynamics of the energy system, in accordance with each country's economy, and determining the principal economic-energy relationships among the different sectors of the national economy.

- To serve as an instrument for energy planning.

- To know the structure of the national energy sector in detail.

- To determine the competitive and non-competitive uses of each energy source, which allow for the stimulation of substitution processes whenever possible.

- To create the appropiate bases, which carry with them improvement and systematization of the energy information.

- To be used in order to permit energy projections and its short-term, medium-term, and long-term prospects.

2. CURRENT SITUATION IN LATIN AMERICA AND THE CARIBBEAN

Of thirty countries existing in the Latin American and Caribbean area, it can be established, in accordance with the information and knowledge available, that some nineteen of them possess energy balances, with distinct levels of breakdowns and historical coverage, as well as different methodological criteria for their elaboration, as seen in Chart N° 1.

For the purpose of a very general analysis of the current state of the said energy balances, the different countries of the region have been regrouped into four large geographic blocks, being:

- Mexico and the Central American Isthmus
- The Caribbean Area
- The Andean Group
- The Rest of South America

2.1 Mexico and the Central American Isthmus

2.1.1 Mexico

It is known that Mexico, through the National Energy Commission, has elaborated the energy balances for the 1968-1978 period, basically using the methodology of the Organization for Economic Cooperation and Development (OECD).

2.1.2 Countries of the Central American Isthmus

With the idea of planning the energy sector of the countries of the Central American Isthmus in an integrated way, the Isthmus Energy Program was implemented in October 1978, under the sponsorship of the United Nations Industrial Development Organization (UNIDO), the economic support from the Organization of Oil Producing and Exporting Countries (OPEC), and the respective governments through their national counterparts, which operated as the executing body.

Within this program, the elaboration of the energy balance is given priority, as the basic instrument for energy planning, a mechanism on which Honduras, El Salvador, Nicaragua, Costa Rica, and Panama are working, with their execution having been begun at different times.

In each country a series of historical energy balances (1965-79) has been done, with a common methodology constituting the starting point for an analysis of the sector's behavior.

The current state in which each Central American country's energy balance can be found can be established as follows:

Costa Rica: This country began work in October 1978, under the control of the Direction of Hydrocarbons, in the Ministry of Economy, Industry and Commerce. In May 1979 the execution of the sub-program was transferred to the Costa Rican Institute of Electrification (ICE), where the work group practically had to be newly formed.

This country has completed its energy balances for the 1965-1979 period, and the results are in the process of being published.

El Salvador: This country began work in November 1978, with the Lempa River Executive Hydroelectric Commission as its national counterpart. It has completed the realization of its historical energy balances for the 1970-79 period, after having overcome a series of problems

Chart Nº 1

ENERGY BALANCES IN LATIN AMERICA AND THE CARIBBEAN 1/

COUNTRIES WITH BALANCE	COUNTRIES WITHOUT BALANCE
1.- Argentina	1.- Bahamas
2.- Barbados	2.- Dominica
3.- Bolivia	3.- Guyana
4.- Brazil	4.- Haiti
5.- Colombia	5.- Jamaica
6.- Costa Rica	6.- Paraguay
7.- Cuba	7.- Saint Vincent
8.- Chile	8.- Saint Lucia
9.- Dominican Republic	9.- Suriname
10.- Ecuador	10.- Trinidad and Tobago
11.- El Salvador	11.- Uruguay
12.- Grenada	
13.- Guatemala	
14.- Honduras	
15.- Mexico	
16.- Nicaragua	
17.- Panama	
18.- Peru	
19.- Venezuela	

1/ Information in accordance with the knowledge possessed by OLADE more related to the lack of statistical information, which meant that the balances for the immediately preceding period (1965-69) could not be realized except in the case of primary energy, for which energy balances have been done for the whole period. It is in the process of publishing a document which will contain the final results and which manifests the importance of considering the energy originating in firewood and plant residues within the national energy panorama.

Honduras: In October 1978, Honduras became integrated into the sub-program, with the Upper Council of Economic Planning (CONSUPLANE) being the national counterpart. So far, the primary and secondary energy balances have been completed, and the determination of the consumption structure is being worked on.

Nicaragua: With the Nicaraguan Energy Institute serving as its counterpart, this country integrated itself into the sub-program in August 1979. Up to now, the primary and secondary energy balances have been completed, except for firewood, for which a national survey has already been realized, with respect to its consumption. With regard to this country's consumption structure, the data are 75% complete.

Panama: This country was incorporated into the sub-program in April 1979, with the Institute of Hydraulic Resources and Electrification acting as its counterpart. The primary and secondary energy balances have been completed, except for the case of firewood, for which a national survey is underway, with some 50% of the projected samples having been taken so far.

In addition, a survey is being realized to determine hydrocarbon consumption, and it is anticipated that the total consumption structure will be completed for approximately October 1980.

Guatemala: It is noteworthy that Guatemala is not incorporated into the sub-program. This is due to the fact that the country already possesses energy balances for 1950, 1955, 1960, 1965 and 1975, elaborated by a consulting firm. It is useful to point out that the methodology used for the elaboration of these balances is not the same as that used for the rest of Central America. Currently, the balances for the 1976-79 period are being elaborated with the said methodology.

2.2 The Andean Group

The countries of the Andean Group are in a process of completing their energy balances for the 1970-79 period, with the expectation that the respective documents will be available by the end of 1980.

2.2.1 Colombia

In 1971 the Colombian Energy Institute agreed to initiate the elaboration of energy balances for the 1960-70 period and projections for the 1971-80 period, a job which was completed in June 1972. Those balances describe the primary energy sources, including firewood and bagasse, and give a breakdown of the final consumption, according to industrial, transportation, residential, commercial, and energy sectors, etc. For the decade of the 70's, the Ministry of Mines and Energy produced, in September 1979, the respective energy balances, with a breakdown similar to that for the 1960's.

In October 1979 the National Planning Department and the Ministry of Mines and Energy agreed to initiate a global energy study, one of whose parts includes the definitive elaboration of the energy balances for the years 1970-79, with a greater breakdown than in the previous studies. In February 1980 this work was begun, and the preliminary balances are expected for October 1980. The methodology being followed is in accordance with the general framework of the "OLADE Methodology for the Elaboration of Energy Balances".

2.2.2 Venezuela

The Office of the General Direction of the Energy Sector, belonging to the Venezuelan Ministry of Energy and Mines, has been working on the elaboration of energy balances since 1976, and currently has a chronological series for 1970-78.

The charts contemplated in the presentation of the said balances include the analysis of: internal sector consumption, transformation balances, the energy sector's own consumption, and the Global Energy Balance.

This information, as well as the methodology used, is undergoing a process of revision and will be published within a short time.

Having this planning instrument, the "Directing Document for the Venezuelan Energy Policy" outlines the parameters and principal strategies for the integral management of the energy resources in this country.

2.2.3 Ecuador

In 1979, with technical advising from the European Economic Community (EEC), the National Energy Institute

(INE) began the project for the 1969-78 energy balances. The methodology used is in accordance with the general outline of the "OLADE Methodology for the Elaboration of Energy Balances".

The project includes an estimate of the consumption of the "non-commercial" energy sources, especially firewood consumption. With respect to the levels of the final consumption breakdown, three large groups are considered: industry and mining, transportation and fishing; and residential, commercial, and others. Given the characteristics of Ecuador, it should be observed that the emphasis is being placed on the important sectors for the country, such as fishing. Moreover, an effort is being made to divide the sectors even further, with 5 subsectors for industry, 8 for fishing and transportation, and 6 for residential, commercial and others.

The definitive results will be presented during the second half of 1980.

2.2.4 Peru

With the purpose of acquiring instruments allowing for the integral planning of energy development in the country, the Ministry of Energy and Mines has elaborated the global energy balance, among other studies.

Six primary sources, 6 transformation centers, 15 forms of secondary energy, and 9 consumption sectors were analyzed. The work required approximately eighteen months to complete; the greater part of the time was destined to obtaining the information and making it compatible. It is worth noting the effort that the analysis of the non-commercial resources required; to this end, a study was realized at the national level, in which more than 8000 interviews were done, thus permitting the determination of their characteristics, the specific consumptions, and their destination in the rural and urban sectors.

To date, an historical series of global balances exists for the 1965-76 period; and the balances corresponding to the years 1977, 1978, and 1979 are being prepared.

In addition, general balances have been elaborated for the years 1990 and 2000, parting from historical tendencies and considering some suppositions, such as greater use of hydroenergy, coal, and the substition of kerosene for charcoal, among others, thus permitting the attainment of an aproximate chart for the country's energy future.

This work is being elaborated with the technical assistance of the United Nations Development Program (UNDP).

2.2.5 Bolivia

The elaboration of, and the methodological criteria for, the energy balances have been based on guidelines prepared by the Free University of Brussels and some general aspects contemplated in the Argentine methodology. The Ministry of Energy and Hydrocarbons has been in charge of their preparation through the National Direction of Electricity.

As in the majority of countries in the region, the information about the use of firewood as a singularly important energy source lacks reliability; however, the figures included for the 1970-77 period permit the establishment of meaningful indicators within the Bolivian energy context.

2.3 The Caribbean Area

Little information is available on the Caribbean area, with the exception of Barbados, Cuba, Grenada, and the Dominican Republic. According to Chart N° 1, the majority of the countries in this area do not have energy balances. However, it is known that the United Nations, ECLA, is developing a study concerning the area's energy resources through the Caribbean Development Cooperation Committee (CDCC).

2.3.1 Barbados

In this country, the compilation of energy balances began in May 1979 through the combined efforts of the Ministry of Trade and Industry, the Central Bank of Barbados, and the Barbados National Standards Institution.

The methodology used is based on the Organization for Economic Cooperation and Development's system of accounts, with some modifications.

The objective is to develop an historical series of balances from 1970 to the present.

To date, primary and secondary energy balances for the said period exist. While energy balances for the years 1977 and 1978 have been completed, the 1979 balance is now being prepared.

2.3.2 Cuba

The Central Planning Board has been systematically elaborating energy balances for several years, within the National System of Economic Planning. The methodology employed is based on that of the countries of the Mutual

Economic Assistance Council (CAME), adapted to Cuba's specific conditions.

Within the annual energy balances and prospects, seven primary energy sources, 4 kinds of energy transformation, 15 forms of secondary energy, and 5 large consumption sectors, broken down into some twenty economic branches, are analyzed.

Currently, energy balance planning for the five-year period of 1981-86 is being worked on, in accordance with the elaboration of the Sole Plan for the Development of the National Economy for the same time period. Furthermore, development strategy up to the year 2000 is being planned.

2.3.3 Grenada

No formal energy balances have been prepared as such; however, a basic five-year series (1975-79) of statistical data pertaining to petroleum sales and the end-uses are available and an attempt will be made shortly to consolidate this information in a formal Energy Balance.

Although the data available pertain to petroleum only, it is still thought that this information will suffice to construct an Energy Balance, as petroleum covers roughly 95-97% of Grenada's energy requirements.

The statistical information is up-dated on a monthly basis, and it is therefore very likely that energy balances can be brought up-to-date. This work is at present being carried out by the newly established Energy Unit of the Ministry of Finance, Trade, Industry, and Planning.

2.3.4 Dominican Republic

Starting in February 1980, with the direction of the National Energy Policy Commission, the program for the elaboration of the national energy balance was begun. The interest and purpose of its elaboration will be the evaluation of the energy sources available in the country and the analysis of the supply and demand of resources, as well as possible behavior prospects up to the year 2000.

The aforementioned Energy Commission has the support of such international organizations as the Inter-American Development Bank (IDB), the Organization of American States (OAS), and the United Nations (UN), aiding in the elaboration of this instrument of policy and in the national energy study.

2.4 The Rest of South America

The rest of South America includes Argentina, Brazil, Chile, Guyana, Paraguay, Suriname, and Uruguay. Two groups are distinguished in this zone: Argentina, Brazil, and Chile, which have realized energy balances, and the other countries, which have not done so.

2.4.1 Argentina

Within Latin America, Argentina was one of the first countries to elaborate energy balances, given that it realized a complete one for 1969 and a partial one for 1962.

In 1974 the State Secretariat of Energy elaborated a series of balances for the 1960-73 period, as a preliminary phase of the structuring of a "national energy model".

From this date on, the country did not have any continuity in the elaboration of this kind of work, and now lacks this information.

The Argentine methodology for calculating the balances is original, assigning the physical values in caloric units equivalent to 1 Tcal = 100 TOE. Seven sources of primary energy, 16 of secondary energy, 5 transformation centers, and 10 consumption sectors are considered.

Besides the balance series already cited, the Department of Information and Applied Research, of the Sectorial Office of Energy Development, has been realizing a type of simplified balance titled "Apparent Consumption" every year, without interruption, since 1951, for which it utilizes the ton of oil equivalent (TOE) as the unit.

Finally, it is useful to note that a series of regional balances for the period 1960-78 has just been finished and presented, elaborated for the Entre Rios Province by the Federal Investment Council, and including a balance of energy reserves and an opening of the consumption sectors at the level of types of uses expressed in useful energy.

2.4.2 Chile

The Chilean experience in energy balance construction is quite old. Thus, in the years 1965 and 1966, the Department of Fuel Energy and Mining of the Production Development Corporation included fairly complete statistical information for the period 1940-64. However, this balance did not consider the sectorial distribution of consumption. Another prior publication exists from the same organization, "Energy and Fuel Plan," which breaks down the information on consumption, but only until 1960; and the figures are not presented in the form of a balance.

During the first six months of 1980, the National Energy Commission finished the work of elaborating the energy balances for the 1960-77 period. In these balances the complete situation of primary and secondary energy is presented, as well as that of the transformation centers and the final consumption centers, broken down into 5 primary energy sources, 17 secondary energy sources, 4 transformation centers, and 3 final consumption centers: transportation, industrial and mineral; and commercial, public, and residential. The final consumption sectors are further broken down into 12 subsectors. The National Energy Commission expects to continue presenting energy balances as the information becomes available.

2.4.3 Brazil

In ctober 1977, the Sao Paulo State Power Company and the Foundation for the Technological Development of Engineering, linked to the University of Sao Paulo, decided to join forces in a project to analyze the demand within that state and in the country, and its prospects for 1990.

In 1978 the results of the work were published; with respect to the energy balances, they only included those corresponding to the years 1970 and 1975, although it cannot be said that they rigorously correspond to energy balances.

2.4.4 Guyana, Paraguay, Suriname, and Uruguay

In these countries, no systematization of energy flows is known to exist.

3. GENERAL STRUCTURE OF THE BALANCE

3.1 General Description

In order to express the relationships made manifest in an energy balance, it is imperative to establish a sufficiently general structure, so as to obtain an adequate configuration of the physical variables proper to this sector.

The balance developed by OLADE reflects the relationships among all of the stages of the energy process: production, transformation, and consumption as ilustrated in Figure N° 1.

The general structure of the balance is composed of four parts:

- Primary Energy
- Transformation
- Secondary Energy
- Final Total Energy Consumption

3.1.1 Primary Energy

In the first part, the relationships relative to primary energy are presented, in turn broken down into total primary supply and gross primary supply, wherein the following equations are verified:

$$OTP = PEP = IMP \pm VIP$$

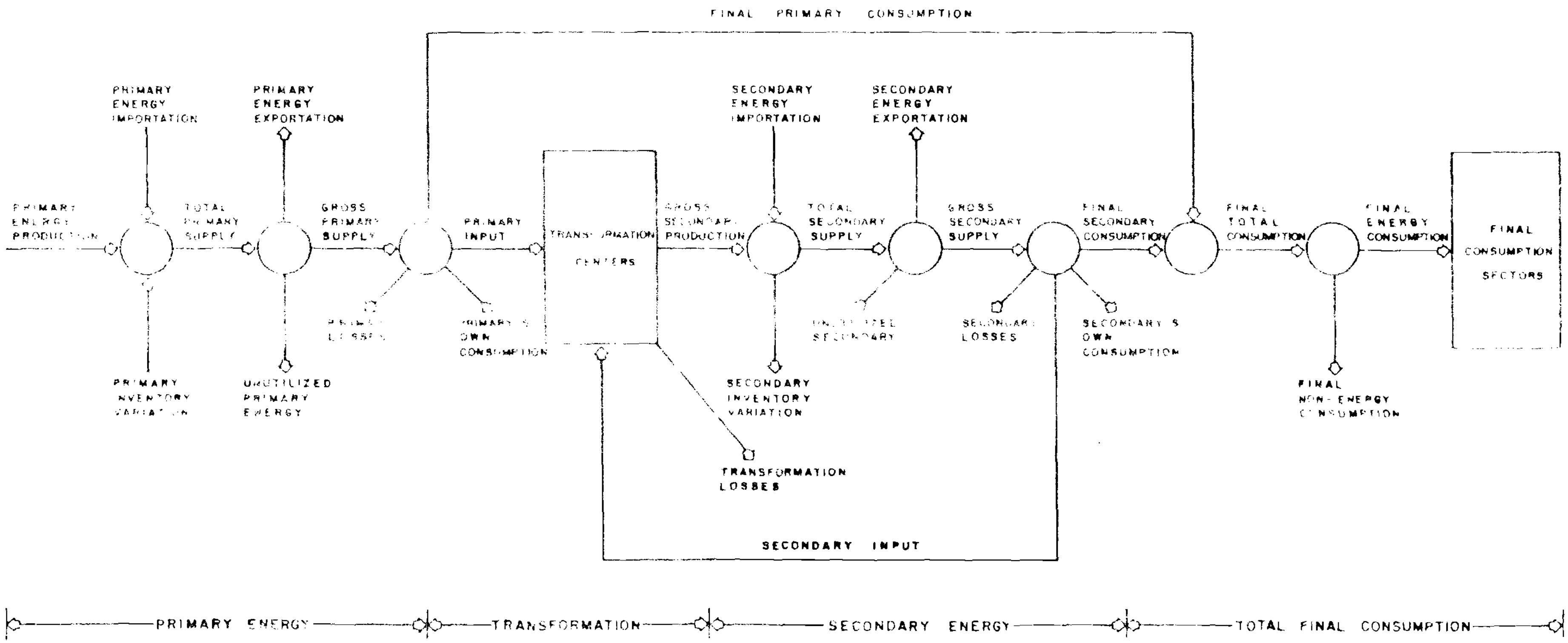
$$OBP = OTP - EXP - NAP$$

Where:

IMP = Importation of Primary Energy
OTP = Total Primary Supply
PEP = Primary Energy Production

Figure Nº 1

OLADE ENERGY BALANCE STRUCTURE



VIP = Variation in Primary Inventory
OBP = Gross Primary Supply
EXP = Exportation of Primary Energy
NAP = Unutilized Primary Energy

In addition, it should be verified that:

OBP = ENP + CFP + CPP + PER

Where:

ENP = Primary Input
CFP = Final Primary Consumption
CPP = Primary's Own Consumption
PER = Primary Losses

This equation indicates that the destination of the gross supply of primary energy may be a flow termed Primary Input for the transformation centers, a flow of primary energy's own consumption, and a flow of primary losses due to transportation, distribution, and storage.

3.1.2 Transformation

The second part is constituted by the transformation centers, wherein the energy which enters is transformed into one or more secondary energies, with the corresponding transformation losses.

In this part, the following equation is established:

PSB = ENP + ENS - PET

Where:

PSB = Gross Secondary Production
ENP = Primary Input
ENS = Secondary Input
PET = Transformation losses

NOTE: For statistical reasons, the gross secondary production does not normally include auto-consumption; for example, the electricity consumed in pumps, lighting, etc., in a power plant.

3.1.3 Secondary Energy

In the third part, the relationships relative to secondary energy are presented, broken down into total secondary supply and gross secondary supply and expressed by means of the following equations:

$$OTS = PSB + IMS \pm VIS$$

$$OBS = OTS - EXS - NAS$$

Where:

OTS = Total Secondary Supply
PSB = Gross Secondary Production
IMS = Importation of Secondary Energy
VIS = Variation in Secondary Inventory
OBS = Gross Secondary Supply
EXS = Exportation of Secondary Energy
NAS = Unutilized Secondary Energy

In addition, it should be verified that:

$$CFS = OBS - ENS - PES - CPS$$

Where:

CFS = Final Secondary Consumption
ENS = Secondary Input
PES = Secondary Losses
CPS = Secondary Energy's Own Consumption

3.1.4 Total Final Energy Consumption

In the fourth part, the final total consumption is shown, wherein the part of the primary energy used directly in the final consumption is added to the final secondary consumption, in order to arrive at the total final consumption. The corresponding equation is:

CFT = CFP + CFS

The total final consumption of energy is distributed between final energy consumption and final non-energy consumption; in other words, for this case, the following equation holds true:

CFT = CFE + CFN

Where:

CFT = Total Final Consumption
CFE = Final Energy Consumption
CFN = Final Non-energy Consumption

In turn, the final energy consumption is broken down into the distinct sectors of economic activity, which, for the present case, have been divided into the following sectors:

- Residential, commercial, and public
- Transportation
- Agricultural/livestock
- Industrial
- Unidentified consumption

3.1.5 Additional Comments

The structure of the energy balance thus conceived can be broadened in the future to contemplate and analyze other stages of the energy sector. Under such circumstances, there exists the possibility of adding the following parts to the balance described:

a. The inventory of reserves for the finite energy sources, and the evaluation of the renewable resources.

b. The distribution of the final energy according to the kind of use in the consumption sectors.

c. The distribution of the useful energy according to the kind of use, for each one of the consumption sectors.

d. The Energy Balance in economic terms.

3.2 Transformation Centers

The second part of the structure presented for the consolidated energy balance refers to the transformation centers, which correspond to the following general scheme:

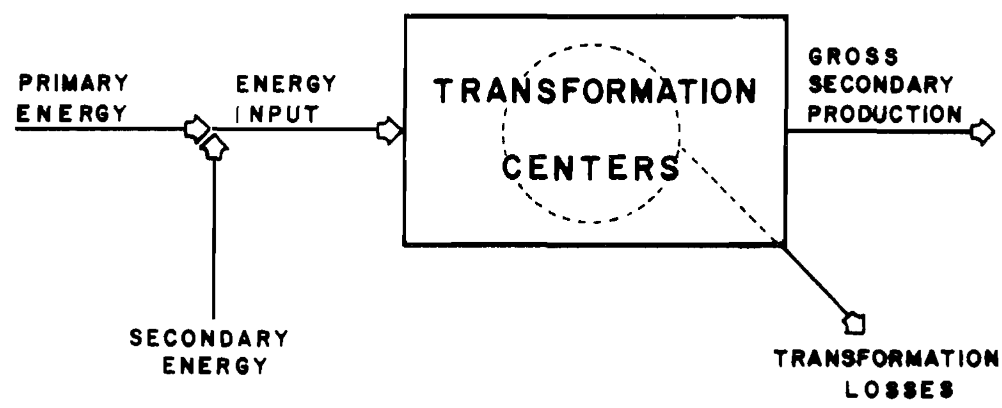


Figure Nº 2

It is evident that, due to the fact that a process is being dealt with, the energy outflow is less than the energy input, and the difference is that which is known as transformation losses, which, for statistical reasons, normally include the auto-consumption of the transformation center. (See Note, Paragraph 3.1.2).

It is important to take into account that, in addition to the transformation losses, the transformation center's consumption must be considered, and it will be included in the energy sector's own consumption.

In the present methodology, the following transformation centers have been considered:

1. Coke Plants and Furnaces
2. Biomass
3. Coal Plants
4. Refineries
5. Gas Treatment Plants
6. Power Plants (Public Service and Self-Use)
7. Plants dor the Elaboration of Nuclear Fuels (Appendix C)

3.2.1. Coke Plants and Furnaces

As can be observed in the figure, coal or charcoal or coke and oil coke enter this center.

In the coke plants where coal is treated, coke, coke gas, and non-energy products (benzol, Tars, etc.) are obtained. In the furnace, part of the coke which is obtained gives rise to the production of furnace gas, and the other part is consumed in the process of reducing the mineral.

Taking into account that few Latin American countries have to manage this aspect of the coke plants and furnaces, it is recommended that each individual country deal with this situation in the way it considers best; in other words, the coke plants and the associated furnaces or separately.

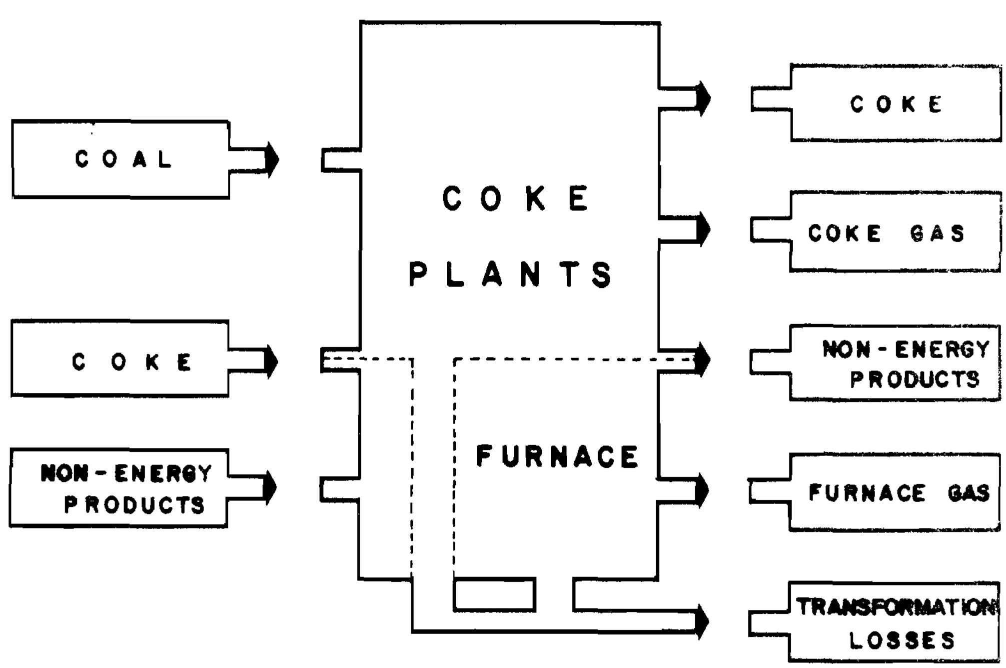


Figure Nº 3

3.2.2 Biomass Transformation Centers

These transformation centers may be anaerobic digesters, alcohol distilleries, pyrolysis furnaces, etc.

The secondary products obtained, according to the case, are: gas for gasogenes or biogas (methane), both being grouped under the heading of gas; ethyl alcohol, charcoal (as a residue in pyrolytic processes) and non-energy products, such as the fertilizers obtained in anaerobic plants.

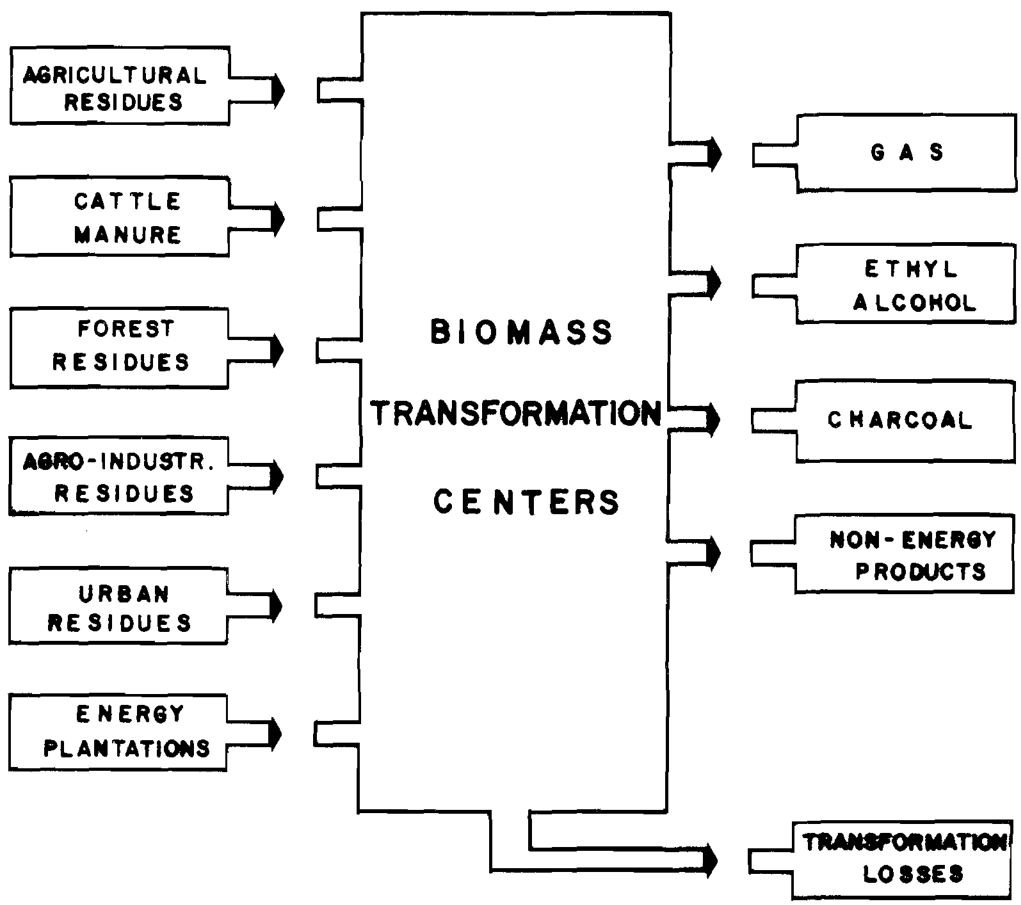


Figure N° 4

3.2.3 Coal Plants

Due to the great importance of the charcoal production in the region, this biomass transformation center is treated separately.

The coal plant is a furnace wherein the partial combus - tion of firewood takes place, producing charcoal, volatile and non-energy products; generally, these last are not utilized.

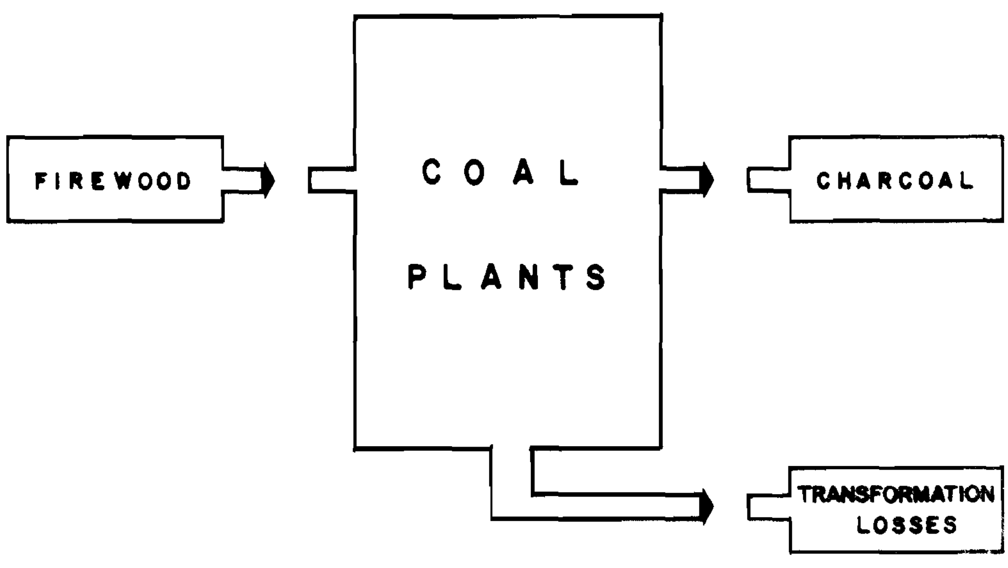


Figure Nº 5

3.2.4 Refineries

Basically, in the refineries crude oil is separated into its different components, as seen in the figure.

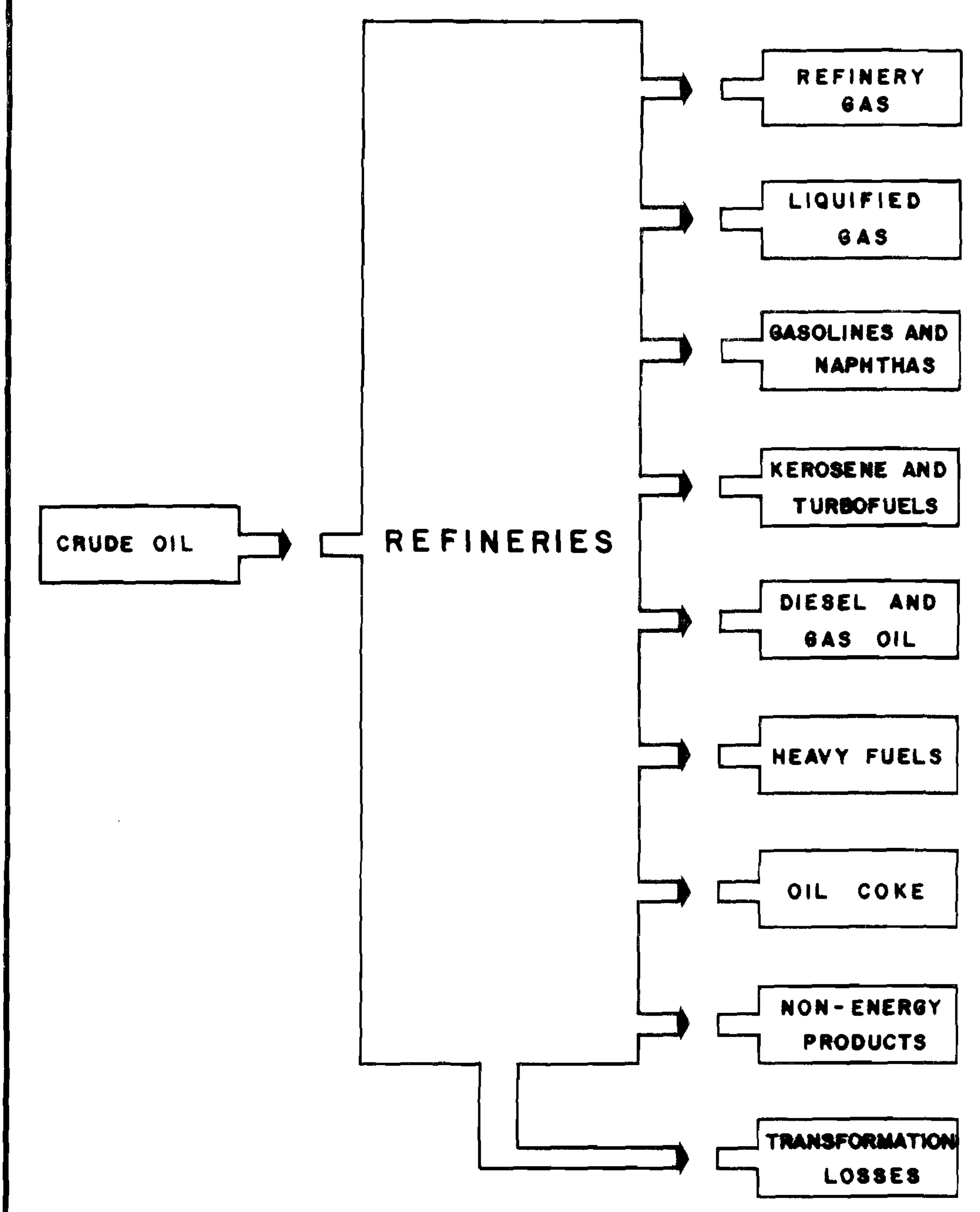


Figure Nº 6

3.2.5 Gas Treatment Plants

In the gas treatment plants, whose scheme can be appreciated in the figure, and wherein a process is carried out to separate the components of free or associated natural gas, the products obtained are gas, liquified gas, gasolines and naphthas, and non-energy products.

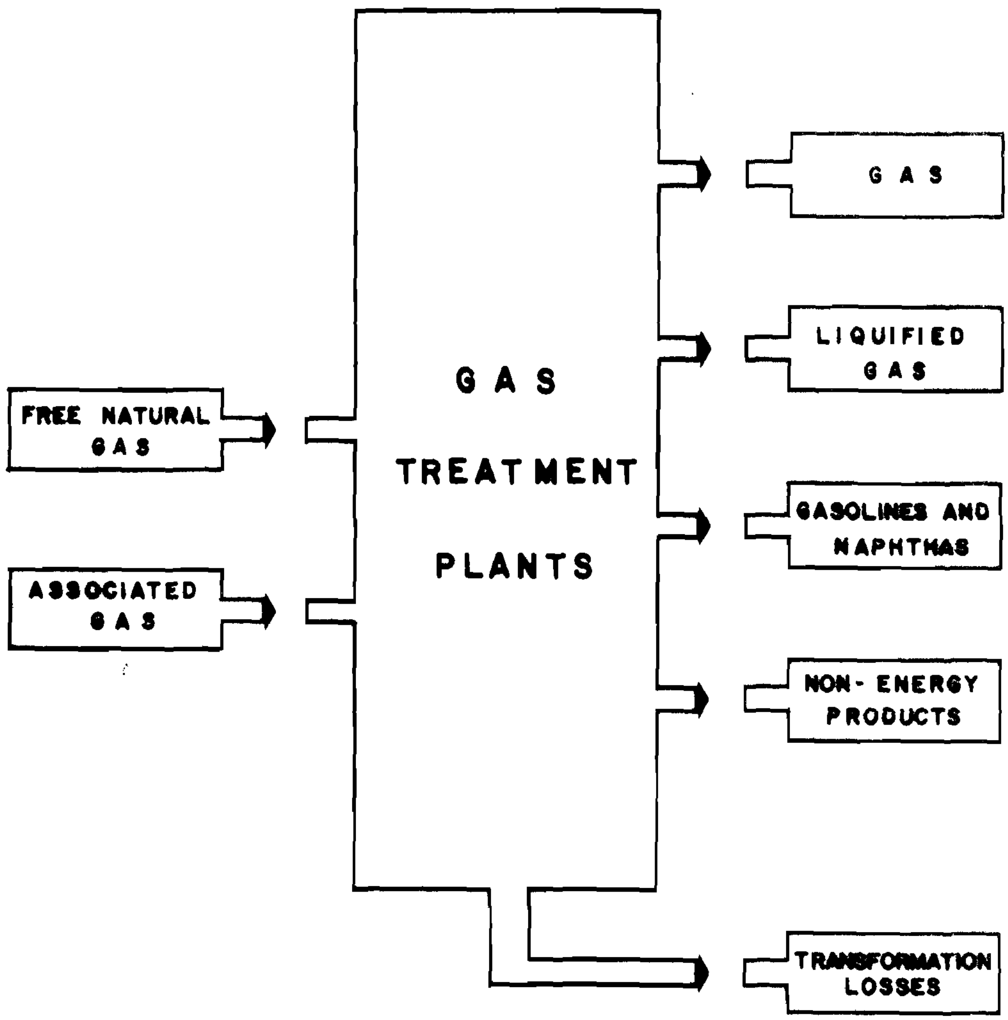


Figure Nº 7

3.2.6 Power Plants (Public Service and Self-Use)

These transformation centers are constituted by hydro-electric plants, conventional thermal plants with steam turbines, gas turbines and internal combustion engines, nuclear and geothermal plants, as the case may be.

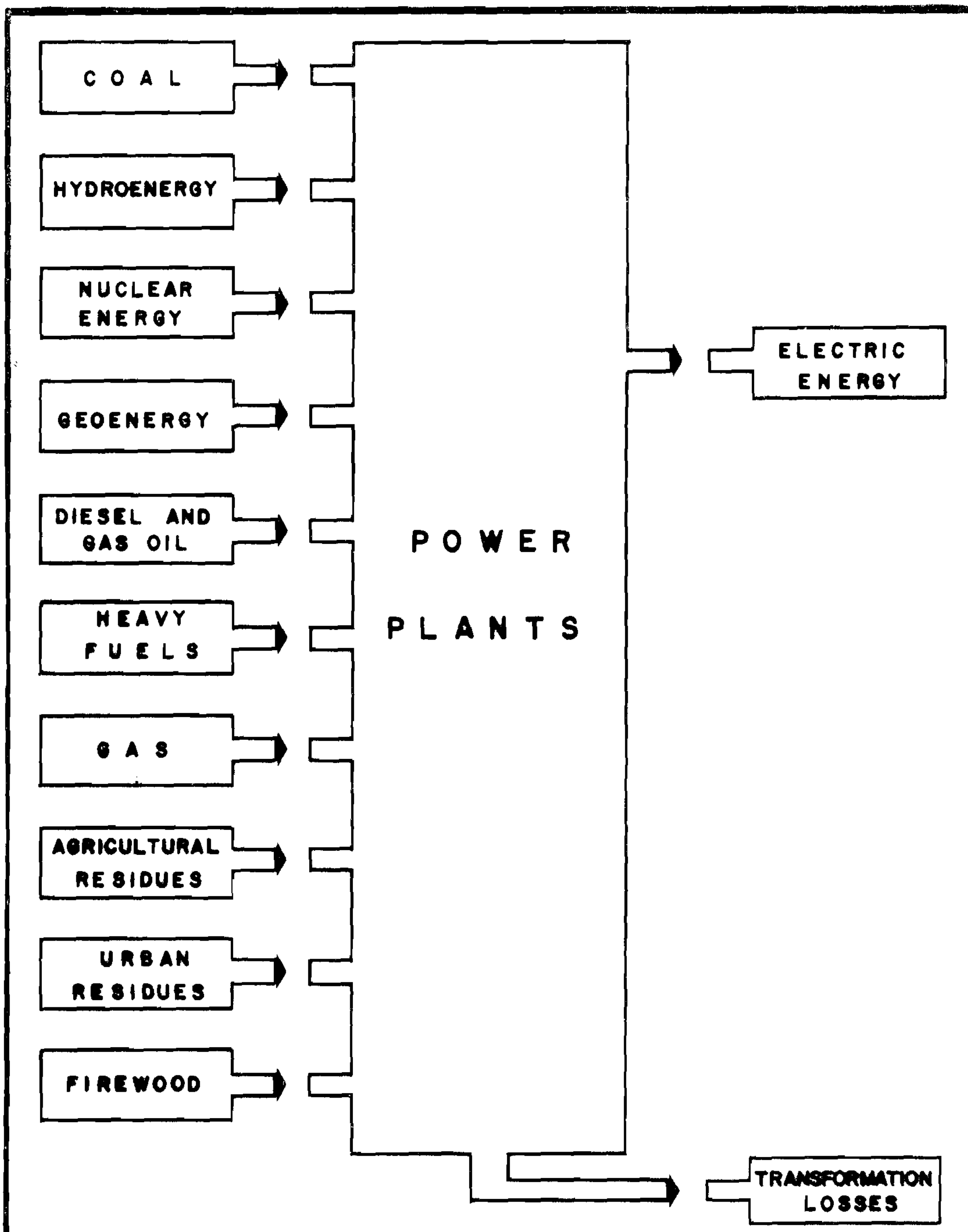


Figure Nº 8

3.3 Format

The format for the presentation of the energy balance consists of a two-dimensional information chart, in which the primary and secondary energies are enumerated in the columns and their origins and destinations are identified in the rows. This format permits the consolidation of the different parts of the energy system in a sole equilibrated group: primary energy supply, transformation, secondary energy supply, and final consumption, thus facilitating the following of the flows for each energy source.

The presentation format has twenty-three columns, wherein the forms of primary energy, secondary energy, their respective totals, and the general total are located.

This format also contains twelve rows, in which the values corresponding to the areas of supply, the energy sector, the adjustments, and the final consumption are calculated (See Charts Nos. 2 and 3).

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Chart Nº 2

UNITS: TOE x 10³

CONSOLIDATED ENERGY BALANCE

YEAR:

COUNTRY:

MINISTRY:

ELABORATED BY:

PLACE: DATE:

				PRIMARY ENERGY										SECONDARY ENERGY												
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
				Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hidroenergy	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECON. ENERGY	TOTAL
ENERGY SECTOR	SUPPLY	1	Production	Primary Energy										Secondary Energy												
		2	Importation																							
		3	Inventory Variation																							
		4	TOTAL SUPPLY																							
		5	Exportation																							
		6	Unutilized																							
		7	GROSS INTERNAL SUPPLY																							
	TRANSFORMATION CENTERS	8	TOTAL TRANSFORMATION																							
		8.1	Coke Plants, Furnaces	Energy Sector																						
		8.2	Coal Plants																							
		8.3	Biomass																							
		8.4	Refineries																							
		8.5	Gas Plants																							
		8.6	Public Service Power Plants																							
		8.7	Self-Use Power Plants																							
		9	Energy Sector's Own Consump.																							
		10	Losses (Transp. Distri. Storage)																							
		11	ADJUSTMENTS																							
FINAL CONSUMPTION		12	TOTAL FINAL CONSUMPTION	Total Final Consumption																						
		12.1	Final Non-Energy Consumption																							
		12.2	Final Energy Consumption																							
		12.2.1	Residential, Commercial, Public																							
		12.2.2	Transportation																							
		12.2.3	Agricultural / Livestock																							
		12.2.4	Industrial																							
		12.2.5	Unidentified Consumption																							

TRANSFORMATION LOSSES

Observations: GROSS SECONDARY ENERGY PRODUCTION

OTHERS:

olade

Chart Nº 3

UNITS: TOE x 10³ — CONSOLIDATED ENERGY BALANCE — YEAR:

COUNTRY:

MINISTRY:

ELABORATED BY:

PLACE: DATE:

			PRIMARY ENERGY										SECONDARY ENERGY												
			1 Coal	2 Firewood	3 Other Plant Animal Fuels	4 Crude Oil	5 Free Natural Gas	6 Associated Gas	7 Hidroenergy	8 Geoenergy	9 Fission Fuel	10 TOTAL PRIMARY ENERGY	11 Coke	12 Charcoal	13 Liquified Gas	14 Gasolines / Naphthas	15 Kerosene and Turbo Fuel	16 Diesel and Gas Oil	17 Heavy Fuels	18 Other Energy Fuels	19 Non-Energy Products	20 Gas	21 Electricity	22 TOTAL SECONDARY ENERGY	23 TOTAL
ENERGY SECTOR — SUPPLY	1.	Production																							
	2.	Importation																							
	3.	Inventory Variation																							
	4.	TOTAL SUPPLY																							
	5.	Exportation																							
	6.	Unutilized																							
	7.	GROSS INTERNAL SUPPLY																							
ENERGY SECTOR — TRANSFORMATION CENTERS	8	TOTAL TRANSFORMATION																							
	8.1.	Coke Plants, Furnaces																							
	8.2.	Coal Plants																							
	8.3.	Biomass																							
	8.4.	Refineries																							
	8.5.	Gas Plants																							
	8.6.	Public Service Power Plants																							
	8.7	Self-Use Power Plants																							
	9.	Energy Sector's Own Consump.																							
	10	Losses (Transp. Distri. Storage)																							
	11.	ADJUSTMENTS																							
FINAL CONSUMPTION	12.	TOTAL FINAL CONSUMPTION																							
	12.1.	Final Non-Energy Consumption																							
	12.2.	Final Energy Consumption																							
	12.2.1	Residential, Commercial, Public																							
	12.2.2	Transportation																							
	12.2.3	Agricultural / Livestock																							
	12.2.4	Industrial																							
	12.2.5	Unidentified Consumption																							

TRANSFORMATION LOSSES

Observations:

	11	12	13	14	15	16	17	18	19	20	21	22
GROSS SECONDARY ENERGY PRODUCTION												

OTHERS:

4. PRESENTATION AND GENERAL GUIDE FOR THE ELABORATION OF THE BALANCE

4.1 Requirements for Statistical Information

The elaboration of a balance requires a great deal of information on the basis of which the format is filled in.

The volume of information to be compiled depends on the availability of statistics to be had, as well as on the degree of complexity of the energy sector of the country being studied.

The gathering of the chronological information necessary for the elaboration of the balance should follow the steps analyzed in Chapter 6.

The data obtained are expressed in the unit of energy adopted by OLADE, the ton of oil equivalent (TOE), for which the conversion from the original units must be made, using the appropriate equivalency tables. (See Chapter 8).

4.2 Agreement of Signs

In the first part of the balance, which refers to the energy sector, each amount tending to increase the energy available in the country is positive: Production, Importation, Transformation Center Output. On the other hand, each amount tending to decrease the energy available in the country is negative: Exportation, Unutilized, Transformation Center Input, Energy Sector's Own Consumption, and losses. The variations in inventory follow the same logic: thus, an increase in the inventory reduces the available energy, and it has to be a negative amount.

Finally, all of the data found in the second part of the balance, in the Final Consumption, should be negative amounts; however, and for obvious reasons of simplification of presentation, they appear as numerical amounts without signs.

4.3 Definitions and Procedures for the Elaboration of the Balance

4.3.1 Primary Energy

The primary energies are those provided by nature, be it directly, as in the case of hydraulic energy; or after undergoing a mining process, as in the case of crude oil, natural gas, coal, fissionable minerals, and geo - energy; or by means of photosynthesis, as in the case of firewood and other plant fuels or fuels of animal origin.

It is useful to clarify that, because this is the first stage of the project, solar and aeolian energy, among others, have not been included; but they may be considered in the future.

Nine primary energy sources are contemplated in the format, along with their total; they are defined below:

Column 1 - Coal: This is a solid mineral, either black or dark brown in color, principally consisting of carbon, hydrogen, and oxygen, with some impurities such as water, ash, and sulphur. Among the varieties known, we find anthracite, bituminous coal, lignite, and peat.

Column 2 - Firewood: This is the energy which is obtained directly from forest resources.

Column 3 - Other Plant and Animal Fuels: These are those resources obtained from agricultural and livestock wastes and forest, agroindustrial, urban and energy plantation residues.

Column 4 - Crude Oil: This is the liquid hydrocarbon utilized as raw material in refineries for processing and obtaining its derivatives. In some cases, this resource can be used directly as fuel.

Column 5 - Free Natural Gas: This is gaseous hydrocarbon, a mixture of light fractions (principally methane and ethane), which is obtained directly from gas deposits.

Column 6 - Associated Natural Gas: This is gaseous hydrocarbon of light fractions which is obtained along with oil during the extraction of the latter in its crude form.

Column 7 - Hydroenergy: This is the potential energy of a hydraulic flux in a given fall.

Column 8 - Geoenergy: This is the energy contained in the steam and/or water extracted from hot underground reservoirs.

Column 9 - Fission Fuel: This is what is obtained from the mineral uranium after the processes of purification, conversion, and/or enrichment.

Column 10 - Total Primary Energy: This is the sum of Columns 1 through 9.

4.3.2 Secondary Energy

The secondary energies are those energy products resulting from the different transformation centers, which normally have the diverse consumption sectors and sometimes another transformation center as their destinations.

Column 11 - Coke: This is a solid fuel of high carbon content, low humidity, and low volatile material content; it is obtained by heating coal to a very high temperature in the absence of air.

Column 12 - Charcoal: This is a fuel originating in the treatment of firewood, which can substitute coke in the iron - and steel - making industrial processes. It is also used in some industries, such as brick-making, and in the residential and commercial sectors.

Column 13 - Liquified Gas: This is the mixture of light hydrocarbons, principally propane and butane, which is obtained from the refinement of crude oil and the treatment of natural gas.

Column 14 - Gasolines and Naphthas: These are the light derivatives obtained from oil refining. The following elements are included in this group:

- Aviation Gasoline: This is a mixture of reformed high-octane naphthas that is used in propeller airplanes with piston motors.

- Automotive Gasoline: This is a derivative of oil or of a mixture of naphthas which, along with certain additives, are used for the functioning of internal combustion engines.

- Cooking Gasoline: This is gasoline with a very low octane which is used for cooking.

- Naphtha: This is a derivative that can be used as raw material in industrial (petrochemical) processes, such as those in refineries.

- Natural Gasoline: This is a product of the processing of natural gas, and it is used as raw material in refineries or is mixed directly with naphthas.

Column 15 - Kerosene and Turbofuels: Kerosene is a fuel used in cooking, lighting, heating, and even as a solvent. Turbofuels are those used in aviation, in reaction and turbopropeller engines, their fundamental difference from kerosene being that they have a lower freezing point.

Column 16 Diesel and Gas Oil: These are heavier compounds than kerosene, which are mainly used in internal combustion engines and gas turbines.

Column 17 Heavy Fuels (Fuel Oil): These are the residual products from oil refinement, which are principally used as fuel for industrial boilers, electric plants, and navigation.

Column 18 Other Energy Fuels: These fuels include alcohol, residual coal, and others

Column 19 - Non-energy Products: These are those derivatives which, even though they may have a significant energy content, are used for other ends. Among them, we find oils and lubricants, asphalt, paraffin, wax, and other solvents.

Column 20 - Gas: This heading groups those secondary gaseous fuels such as: distributed gas, refinery gas, furnace gas, coke gas, and others.

Column 21 - Electricity: This is the energy composed of moving electric charges which can produce heat (heating, lighting), chemical energy (electrolysis), and kinetic energy (engines).

Column 22 - Total Secondary Energy: This is the sum of Columns 11 through 21.

4.3.3 General

This consolidates all of the energies produced, transformed and consumed in the country.

Column 23 - General Total: This is the sum of Columns 10 and 22.

4.3.4 Supply

This is the amount of energy that remains at the disposition of the energy sector and the country's final consumption. It is obtained by adding the balance of external trade to the national production and the inventory variation.

Also, the energy that is not utilized in any production process is quantified in the supply.

Within the concept of supply, the following have been considered

<u>Row 1</u> <u>Production</u>: This refers to the energy obtained from mining deposits; animal, plant, and forest resources, hydraulic potential, geothermal reservoirs, and fission fuels.

In the format, the amounts corresponding to the primary energy originating in the country will be denoted with positive signs.

This grouping should take into account that in the cases of coal and fission fuel, the considered amounts are those which correspond to washed coal and fission fuel prepared for its direct utilization in power plants.

In the case of hydroenergy, production will be calculated as the sum of the energy obtained from the turbined fluxes in the plants, plus the energy equivalent to the fluxes spilled at the weirs and gates.

For geoenergy, production will be defined by the enthalpy contained in the mass extracted at the well-heads of the geothermal fields; in the case of reinjection, the reinjected mass will be discounted from the extracted mass.

<u>Note</u>: In those cases where it is not possible to determine the production of hydroenergy or geoenergy as proposed above, it is recommended that a hypothesis be made on the basis of the electric energy or caloric energy produced.

Row 2 - Importation: This is the amount of primary and secondary energy originating outside the country and entering it to form part of the supply; it is characterized by a positive sign.

Row 3 - Inventory Variation: This is the difference between the initial and final existing inventories, for each year and for each form of energy.

An increase in the storage of energy in a given year represents a reduction in the total supply and, therefore it should be characterized by a negative sign, and vice versa.

Row 4 - Total Supply: This is the amount of energy that is theoretically available for the country's consumption; it includes the exported volume and the unutilized energy. It is equal to the algebraic sum of Rows 1 (Production), 2 (Importation), and 3 (Inventory Variation).

Row 5 - Exportation: This is the amount of primary and secondary energy sent outside the country; it is identified with a negative sign.

Row 6 - Unutilized: This is the amount of energy which, due to the technical and/or economic nature of its exploitation, is not currently being used.

The amounts in this row will be denoted with a negative (minus) sign. The most common cases dealt with under this heading are energies corresponding to:

- Volumes of spilled crude oil
- Volumes of natural gas burned in the air
- Spilled fluxes in hydro-power stations
- For geothermal energy, the difference between the mass of steam and/or water extracted and the mass of steam used to feed a power plant or another installation.
- Volumes of refinery gas burned in the air.

The criterion of the national groups is considered important in resolving the particular cases of each country.

Row 7 - Gross Internal Supply: This is the amount of primary and secondary energy that is put at the disposal of the country for undergoing the processes of transformation, distribution, and consumption; it is the algebraic sum of Rows 4, 5, and 6.

4.3.5 Transformation, Own Consumption, and Losses

The transformation sector groups all of those transformation centers wherein the primary and/or secondary energies undergo processes that modify their properties or original nature.

In the format, seven transformation centers have been contemplated. These group a wide range of installations; nevertheless, there remains the possibility of adding other, unspecified centers which may be considered important.

Row 8 - Total Transformation: The amount placed in this row for Column 1 through 21 represent the algebraic sum of the primary and secondary energy which enters and leaves the group of transformation centers.

It is calculated as the algebraic sum of the values for Rows 8.1 through 8.7.

Rows 8.1 through 8.7 - Transformation Centers: In all of these rows and between Columns 1 through 9, the primary inputs are transcribed with minus signs. The amounts noted in Columns 11 through 21 are indicated with plus signs (secondary energy production), except in the cases of recycling, which will be indicated with minus signs (inputs of secondary energy in the transformation centers).

An example of the recycling of secondary energy is the diesel produced in the refinery, Row 8.4, Column 16, which is indicated with a plus sign. The part of this volume which serves to feed the power plants will be indicated in Rows 8.6 and 8.7, with a minus sign.

Rows 9 - Energy Sector's Own Consumption: This is the energy utilized for the production, transformation, transportation, and distribution of the energy.

The amounts for each source consumed by the energy sector must be recorded in Columns 1 through 21 and characterized by a minus sign. An example is the electricity consumed in the refineries.

Row 10 - Losses (Transportation, Distribution, and Storage):

These losses occur during the activities that are realized in the supplying of energy, from its production to final consumption. Among others, one can mention the losses in gas pipelines, oil pipelines, the storage of hydrocarbons, electric transmissión lines, and the distribution networks for electricity and gas.

This row includes the losses of all of the energies enumerated from Columns 1 to 21, calculated with minus signs.

4.3.6 Statistical Adjustments

Statistical adjustment is a netly mathematical tool used to make the data corresponding to the net supply and the final consumption compatible, since these arise from different statistical sources; nevertheless, much care should be taken with adjustments, and these should, in no way, be converted into an easy way of resolving all of the statistical problems. It is recommended that, insofar as possible, the statistical adjustment be less than 5% of the final consumption.

Row 11 - Adjustments: This row quantifies apparent earnings or deficits for each energy, the product of information, measurement, and statistical errors.

The adjustments for each column (1 through 23) are calculated with the following formula:

ADJUSTMENTS = FINAL CONSUMPTION - NET SUPPLY

Where:

NET SUPPLY = Row 7 + Row 8 + Row 9 + Row 10

FINAL CONSUMPTION = Row 12

The adjustments will be negative if the supply is greater than the consumption, and vice versa.

4.3.7 Final Consumption

This part details the different sector of the country's socio-economic activity, wherein the primary and secondary energy converge to form the total final energy consumption.

The sectors considered have been grouped under four headings, which classify a country's most important socio-economic activities, such as residential, commercial and public, transportation, agricultural/livestock, and industrial.

The countries which have a greater breakdown in their information may well use a different breakdown for the subsectors, as is useful for them.

Row 12 - Total Final Consumption: This is the energy that is available to be used by all of the sectors of final consumption in the country, including those volumes utilized to non-energy ends.

It is the sum of Rows 12.1 (Final Non-energy Consumption) and 12.2 (Final Energy Consumption), represented with a plus sign. (See Paragraph 4.2: Agreement of Signs).

Row 12.1 - Final Non-energy Consumption: These are the amounts of energy contained in the products used in different sectors, for non-energy ends.

This row includes the total for the non-energy products and the consumption of energy with non-energy ends, for examples, gas as raw material in petrochemical processes; these are denoted with plus signs.

Row 12.2 - Final Energy Consumption: This consumption refers to the total of energy utilized by all of the consumption sectors in the realization of their socio-economic activities.

It is the sum of rows 12.2.1 through 12.2.5

Row 12.2.1 - Residential, Commercial, and Public Sector:

This includes consumption by rural and urban families and by all kinds of business and public services, such as lighting, water supply, etc.

Row 12.2.2 - Transportation Sector: This includes the consumption directed to individual and collective movilization of people and goods, by land, sea, river, or air.

Row 12.2.3 - Agricultural/Livestock Sector: This is the energy consumed in the realization of all the activities directly related to agriculture and livestock-raising. Examples of these consumptions are: the electricity required in pumping and irrigation, the derivatives used in mechanized agriculture, livestock-raising, etc.

Row 12.2.4 - Industrial Sector: This heading is comprised of the consumption of of all of the branches of industry, among which mention can be made of mining, steel, petrochemical, textile, fishing, and food in general.

Row 12.2.5 - Unidentified Consumption: This groups that consumption which cannot be classified in any of the foregoing sectors on the basis of the nature of the information compiled.

4.3.8 Observations

Gross Secondary Production: This additional row permits reading the gross amounts of secondary energy produced in the transformation centers; it is calculated as the sum of the positive (plus) values which appear in rows 8.1 through 8.7

Others: This groups any kind of technical or statistical clarification which differs from or complements the methodology adopted for this balance.

5. TREATMENT OF THE INFORMATION

5.1 Preliminary Data Gathering

The first step in the construction of energy balances is termed preliminary data gathering. It consists of compiling all of the data published, be they systematic or not, in the format in which they normally appear.

The important part of this phase will be to have the certainty that all of the written data has been detected, so that the information gathered will really reflect that which exists.

It must also be kept in mind that no attempt at analysis is yet being made, but rather we are dealing with simple accumulation, where quantity is more interesting than quality. This task has the additional virtue of familiarizing the researcher with the institutions related to the energy system and their respective publications, indicating the point of departure for the current state of the national statistical system.

5.2 Establishment of Formats

This is the fundamentally qualitative stage, where an attempt is made to transcribe the compiled information into special formats, while respecting certain rules of compilation.

It must be emphasized that the format in which the balances are finally presented must never be completed directly, but rather by means of certain intermediate steps.

First, it is recommended that the information be organized by products in the principal charts. The title of the category corresponds to the name of the product (for example, "Coal". See Chart N° 4). The rows are the years which form the series of time, and the columns carry all of the flows that correspond to the product, such as: origin or production, importation, exportation time, and the columns carry all of the flows corres_ pond to the product, such as; origin or production, importation, exportation, inventory variation, unutilized, etc., leaving the last column, termed "adjustments", which serves to indicate sta_ tistical differences. This type of format has the virtue of permitting the visualization of all of the information relative to one product, in one single chart.

Then, an auxiliary chart is defined, whose title or heading is each one of the columns of the principal chart (for example, "coal production". See Chart N° 5). As rows, they again have the years; and as columns, the interesting components of each one of the columns from the principal chart.

Note: With reference to the fact that in some cases the auxiliary charts are too simple, the national work group may well avoid their elaboration and opt for going straight to the principal chart.

5.3 Compilation Sequence (Figure N° 9)

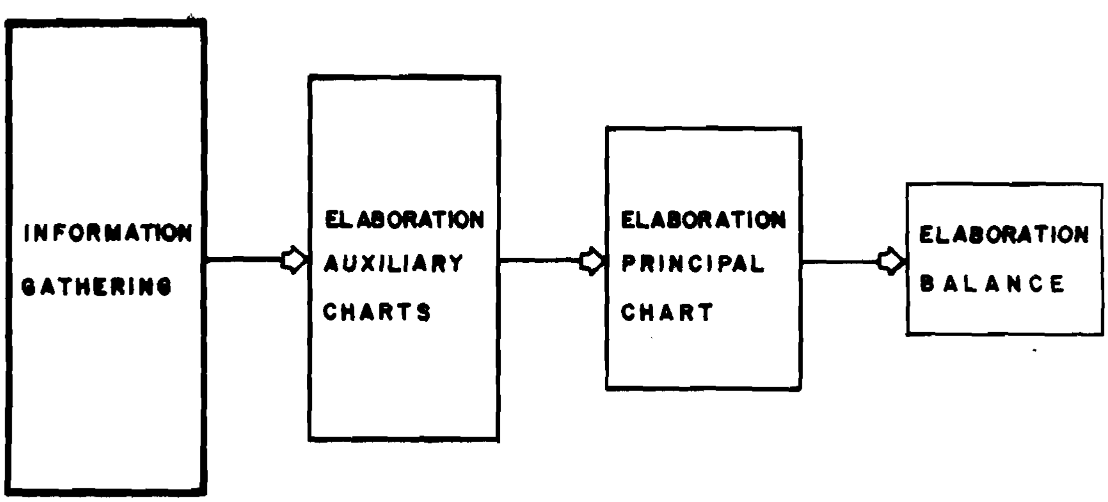

Figure N° 9

Chart Nº 4

C O A L

ITEMS / YEARS	Production	Importation	Inventory Variation	TOTAL SUPPLY	Exportation	Unutilized	GROSS INTERNAL SUPPLY	TOTAL TRANSFORMATION	Coke Plants / Furnaces	Public Service Power Plants	Self-Use Power Plants	Energy Sector's Own Consumption	TOTAL FINAL CONSUMPTION	Non-energy Consumption	Final Energy Consumption	Residential, Commercial, Public	Industrial	Unidentified	ADJUSTMENTS
1972																			
1974																			
1976																			
1978																			

SOURCES:

Chart Nº 5

PRODUCTION COAL

YEARS \ ITEMS	MINE "A"	MINE "B"	MINE "C"	NATIONAL TOTAL
1972				
1974				
1976				
1978				

SOURCES: ____________________

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Chart N° 6

FORM FOR RURAL QUESTIONNAIRES ON FIREWOOD CONSUMPTION

<table>
<tr><th rowspan="2">Interview Number</th><th rowspan="2">Zone, Region, Valley etc.</th><th rowspan="2">Number of people eating in household.</th><th rowspan="2">Number of times per day that family cooks with this energy agent.</th><th colspan="2">Duration, in days of adopted unit for a family.</th><th rowspan="2">People meals per day.</th><th rowspan="2">Observations</th></tr>
<tr><th>original unit</th><th>adopted unit</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</table>

By rigurously following this order, each number that appears in the final format is givena totally documented history, so that no step is missed in its calculation. In addition, this permits the realization of the diagnosis of the information.

5.4 Diagnosis of the Information

In the task of completing the principal chart, it is very useful to do a diagnosis of the information, which is classified according to the following scheme:

- Total
  - Existent
    - Systematic
      - Consistent
      - Inconsistent
    - Non-systematic
  - Non-existent

If percentages are placed in this plan according to the first attempt to complete the formats, this defines the initial state. For example, a country may have only 30% of the existing information in a systematic and consistent form, but in the final state it must have at least 90%. In order to obtain that, it will be necessary to establish certain criteria for consistency and subject the information to them.

5.5 Consistency Criteria

Three criteria for consistency can be defined:

5.5.1 Equilibrium between Supply and Demand

For each product, the production plus the importation must be equal to the consumption plus the exportation, plus the unutilized energy, plus the inventory variation, within a ± 5% tolerance. This tolerance defines the statistical limits and lends a degree of reliability to the information system. By means of this criterion, the cases of duplication or lack of some component in the formation of a final datum can be resolved.

5.5.2 Historical Linkage

For each series, a logical historical behavior, or at least one explicable to the point of having no inexplicable discontinuities, must be determined. This permits the resolution of the cases in which there have been unspecified changes in the compilation criteria for the existing information.

5.5.3 Transformation Relationships

Once all of the independently consistent primary and secondary energy series have been obtained, the yields of the transformation centers must be assured as falling within the technical limits corresponding to the respective transformation installation. For example, the thermal power plants cannot normally appear with yields higher than 35%.

Applying these criteria and processing the inconsistent information, the latter can become consistent.

With regard to the unsystematic, it must first be transformed into systematic information, completing all of the years that are lacking through estimates and later verifying their consistency. That only leaves the nonexistent information, which must be elaborated with appropriate methods.

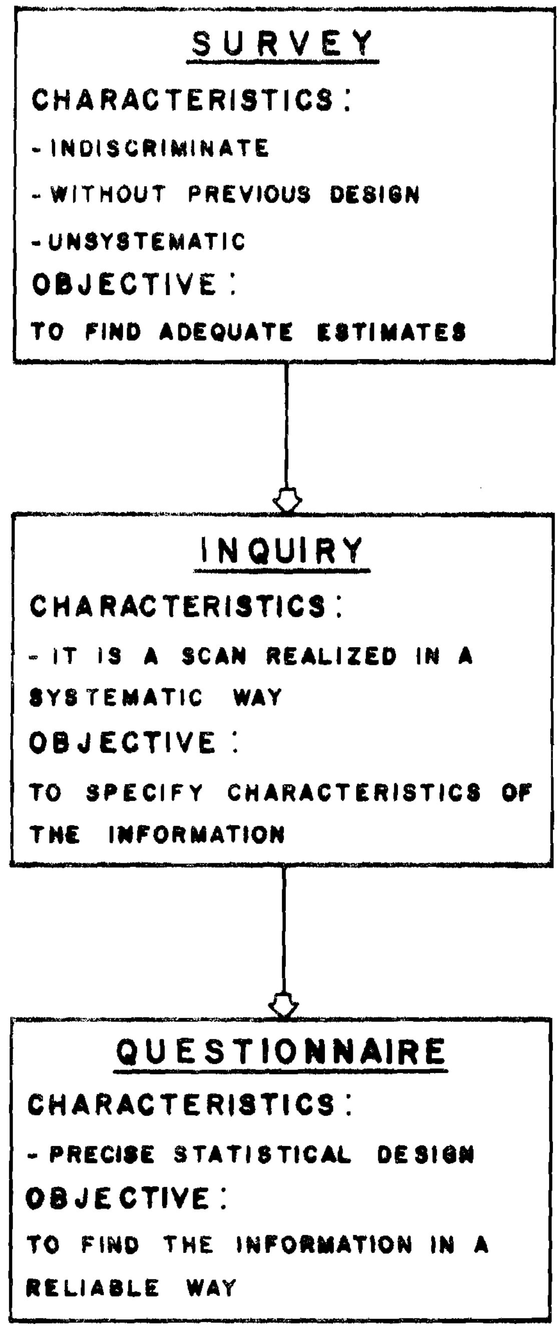
SURVEY
CHARACTERISTICS:
- INDISCRIMINATE
- WITHOUT PREVIOUS DESIGN
- UNSYSTEMATIC
OBJECTIVE:
TO FIND ADEQUATE ESTIMATES
INQUIRY
CHARACTERISTICS:
- IT IS A SCAN REALIZED IN A SYSTEMATIC WAY
OBJECTIVE:
TO SPECIFY CHARACTERISTICS OF THE INFORMATION
QUESTIONNAIRE
CHARACTERISTICS:
- PRECISE STATISTICAL DESIGN
OBJECTIVE:
TO FIND THE INFORMATION IN A RELIABLE WAY

Figure Nº 10

5.6 Scans, Inquires, and Surveys

Finally, in the process of treating the information, the non-existent, or apparently non-existent, information must be generated; and for this, the scan, the inquiry, and the survey are basically used.

The scan is a method which consists of personal or institutional interviews, which can provide certain leads for adequate estimates. It has the characteristics of being done in a quite indiscriminate way and without a previous design.

When a group of scans are done in a more systematic way, where the subsequent interview depends on the data obtained in the previous one, we have an inquiry.

When, in addition to the foregoing, a statistical design is made, for the taking of samples, as well as for the analysis of the results, we have a survey.

The global conception of the whole process is indicated in Figure N° 10.

6. TREATMENT OF NON-COMMERCIAL ENERGY

Recommendations for the Realization of a Simplified Survey in the Rural Area and Small Urban Centers.

6.1 Introduction

It is beyond all doubt that the realization of a national energy balance in the Latin American countries must deal with the rural energy problems as rigurously as with those assigned to the rest of the energy system.

The first difficulty that appears on trying to identify the object of the study is the problem that it is not possible to find a simple, unique terminology that covers all aspects of the case. If the term "non-commercial energy" is adopted to emphasize the fact that these energies are often directly appropriated by the user, we run the risk of leaving aside all of those cases in which a commercial transaction is produced, with a definite price.

As an example, it is sufficient to mention the case of wood charcoal, which is sold in urban markets at a given price, like any other product, but whose production is generally realized in artesanal units where the firewood that serves as raw material has been directly appropriated.

The term "rural balance" could also be used, to refer to the socio-economic category of the user, but what happens, then, to the products traditionally catalogued as commercial, which, as in the cases of liquified gas, kerosene, and gas, are consumed in the rural area in a pattern that is not qualitatively different from the urban one. Inversely, in many countries the urban sector proper consumes firewood, coal, and even animal excrements.

The problem is further complicated on including certain industrial units, ranging from sugar plantations or coffee cultivations to small artesanal units of a net rural character, which can be consumers of firewood, coffee husks and chaff, and other residues.

Thus, we see that no simple terminology can give account of all the possible cases which might present themselves to a researcher who wants to construct a complete energy balance.

This leads to the following reflection: "What do all of the cases under consideration have in common?". Two principal characteristics can be cited to define these energies.

a. The first deals with energies originating in plant or animal (biomass) resources, sometimes as a sub-product of agricultural or forest activities, and being susceptible to direct appropriation.

b. The second deals with products that can only be quantified by means of specific surveys directed to the consumer. The economic cycle then goes directly from the resource to the consumer, without the intermediate step in supply, without which it is impractical to use the traditionally called "commercial" energies such as oil, gas, hydro, geothermal, etc.; and it is precisely the non-existence of this supply sector, which in other cases is the generating nucleus of information, which determines the lack of statistics in this case.

From the foregoing, an interesting property to point out in this work can be manifested: the survey. The objective of this section is to establish a guide on how to take samples and interpret the results.

To begin, two cases may be established:

a. When the number of consumers is infinite with respect to the sample (the case of household consumption).

b. When the number of consumers is comparable to the size of the sample (brick-making and lime industries, etc.).

In Point 6.2 the first case is dealt with, which is the more complicated. In Point 6.3, termed "Special Tests", the second case is described.

6.2 Tests Related to the Cooking of Food

First of all, it is important to clarify that due to the necessity of realizing a simple, rapid survey, the size of this is quite reduced (approximately 500 surveys); and, therefore, the choice of the sites where it is to be applied is especially important. Much care must be taken for this step, which is fundamental to the success of the test.

Below, a simple design is put forth for the taking of small samples, with the purpose of otaining an approximate result for firewood consumption (or that of other products) in the cooking of food, which is the most important use of the domestic sector. A complete treatment of this subject can be found in the energy balance publications from Peru (1979), El Salvador (1980), Costa Rica (1980), and Ecuador (1980).

Here, only a simplified treatment, compatible with a sample no larger than 500 units, is indicated. (It should be pointed out that the aforementioned publications dealt with samples of between 5000 and 10,000 cases).

6.2.1 Units

The first problem to be resolved is that of the units in which the rural inhabitant expresses his consumption; and these vary significantly from one country to another, and even from one region to another within the same country.

In the first place, an attempt is made to discover the unit most often used, that is, the one that the majority of the population understands. (For example, this was "the burro's load" in Peru and "the woman's bale" in El Salvador).

Before gathering data, it is recommended that some twenty weight trials first be made for the most used unit (for example, using Roman-type scales with an approximate capacity of 50 kg). The is sufficient to obtain an acceptable average and to establish the equivalency of this unit in kg. If necessary, it is recommended that an additional twenty trials be made to measure other units different from the most common, in order to determine their equivalency with the latter.

The diversity of rural units is great; but in all of the countries where these surveys have been realized, one unit that is used, or at least understood, by the majority of the population has been detected. This constitutes an essential aspect of this statistical design, and it is taken as the basis for compiling data. More precisely all the data will be expressed in the said unit, which from here on will be known as "the adopted unit."

6.2.2 Data Gathering

The taking of samples is based on the following definitions:

C = Specific consumption in kg/person per meal
K = Equivalent in kg of the adopted unit
Y = Duration, in days, of the adopted unit for a family
Z = Number of people who eat in the household
k = Number of times a day that the family cooks with this energy agent.
X = kZ = People - meals per day

Given that the person interviewed will not always respond in the adopted unit, there is the possibility that the duration (Y) may be expressed in another unit, which we call the original unit (O.U). In such a case, the interviewer must later calculate the Y value in the adopted unit (U.A). This procedure minimizes errors since the responses are obtained directly and the errors originating in equivalencies may be minimized. All of the measurements can be placed in Chart N° 6.

For gathering data, each interview must be a random event, and the interviewer must avoid the tendency to influence the interviewee with his own ideas. Thus, the three key questions are the following:

1. How many people eat here: (verify if the interviewee is including himself). Answer = Z

2. How many times do you cook with ... firewood? (verify that there is no mixture of fuels, such as firewood and kerosene, firewood and gas, etc.) 1/
   Answer = k

3. How many days does a load, a bale, etc., last you?
   Answer = Y

The interviewer must take down all of the data, as absurd as they may seem; but he may use the column for observations to note the occasional original unit used, his own opinion, or anything that may be important.

1/ The cases in which there is a mixture merit a more complicated treatment, and it is preferable to discard them in a simplified survey.

6.2.3 Treatment of the Results

Once the forms have been completed for at least 500 interviews, the next step is to examine these.

The key variable in the treatment of the information is X (people-meals per day). First, the arithmetic mean of this variable ($\bar{X}$) is calculated, along with its standard deviation. Two cases may occur:

- The standard deviation may be significant (more than 10% of ($\bar{X}$). In this case, the complete methodology presented in Appendix B must be used.

- The standard deviation may be small (less than 10% of ($\bar{X}$). In this case, a simplified treatment of the information may be developed, as follows.

A small standard deviation means that homogeneity exists in the sample, with respect to the number of people per family and the number of meals per day. This may occur despite quite different geographical areas.

In such a case, the calculation of the specific consumption (C) is very simple, and it is defined by the relation:

$$C = \frac{K}{\bar{X}\,\bar{Y}}$$

Where:

C = Specific consumption expressed in kg/person per meal
K = Equivalent in kg of the adopted unit
$\bar{X}$ = Mean previously calculated for X
$\bar{Y}$ = Mean duration, in days, of the adopted unit, for a family.

It is useful to point out that for the calculation of ($\bar{Y}$) the points which are excessively distant form the mean should be rejected; nevertheless, the rejection should never exceed 10% of the total amount of points composing the samnle.

In order to go from (C) to the annual national consumption (Q), expressed in kilocalories, the following formula is employed:

$$Q = 365\ \bar{k}.C.Pc.Nj$$

Where:

Q = Annual national consumption in kcal
$\bar{k}$ = Average number of meals per day
C = Specific consumption previously calculated in kg/person per meal.
Pc= Calorific power of the firewood utilized, in kcal/kg
Nj= Number of people that used firewood for cooking in the year j.

As for Pc, if better data are not available, it is suggested that 3600 kcal/kg be taken, given that it is the most commonly found value in the measurements taken so far; but it must be kept in mind that this value can vary quite a bit with the humidity content.

Nj is a value which is normally obtained from housing censuses, or in a given situation, it may be interpolated for an inter-censal period. In cases where this datum cannot be obtained in this way, normally the number of kerosene and gas users is known, and the number of firewood users can be obtained by difference.

In general, there is always some indirect method of determining the number of users. As a last resort, these can be taken as the totaly of the rural population, and the alternative of comparisons with other countries of a similar structure always remains.

6.3 Special Tests

6.3.1 On the Use of Firewood at the Industrial Level

With respect to the research done so far in Latin America, it can be said that industrial consumption is between 3% and 15% of the consumption calculated for cooking. In this case, it is recommended that specific surveys be realized, whose characteristics depend on the type of industrial activity being dealt with, be it brick-making, lime works, bakeries, salt works, pottery works, etc.

An attempt may be made to generalize this test, supposing that they are processes where a given product is manufactured (bread, bricks, lime, etc.) on the basis of a baking or drying process.

The total annual consumption can be calculated as follows:

The variables are:

X = Number of units of the product which are extracted per burning.
Q = Number of burnings realized in the year
Y = Amount of firewood, in kg that is used per burning
C = Specific consumption in kg/unit

Thus, we have:

$$C = \frac{Y}{X}$$

Once no doubt exists with respect to the determination of the specific consumption, the next step is to determine the production, whether it be done directly or by means of estimating the number of product units consumed annually by the population, and within that, determining the proportion of those manufactured with firewood. This procedure proves very difficult to generalize about, since it greatly depends on the type of economic and population indicators which each country has. Nevertheless, it remains to affirm that in the experiments realized to date, it has always been possible to obtain an adequate result.

The methodology for treating the results is similar to that used in Paragraph 6.2.3, and it is also presented in Appendix B.

6.3.2 On the Use of Agricultural Wastes in Industry

Taking into account that in many Latin American countries agricultural/livestock wastes are used in some industries, it is recommended that specific research on this kind of consumption be realized, if the work group should consider it important (for example, bagasse in the sugar industry).

6.4 Comparison with Other Countries

What has been said so far makes an attempt to summarize the experience existing in the region with respect to this subject, with the aim that it serve as a guide for a methodology of simplified application within the perspective which it can provide; although the result may not be precise, at least it will evaluate the order of magnitude.

The not-to-be disdained resource of using comparative data from the countries where surveys have most completely been applied must not be overlooked. At any rate, it is necessary to point out that only practical experience permits the minimization of the errors that can be committed in the gathering of data, as well as in the interpretation of the results.

7. UNITS

7.1 Adopted Unit

For the purpose of expressing the flows that form the energy balance in one unit and for facilitating the grouping of the different variables, a common unit should be adopted.

Keeping in mind that the officially adopted international unit is the Joule but that it has not as yet achieved a high degree of use, and that in the near future OLADE might well express its balances in that unit, the ton of oil equivalent (TOE) has been chosen transitionally, for the following reasons:

a. It is coherent with the MKS system.
b. It acceptably expresses a physical reality for that which it represents.
c. It is directly related to the most important kind of energy in the world today.

Assuming a calorific power of 10,000 kcal/kg for oil, we have the following equivalencies:

1 TOE = 10^{10} calories
1 TOE = 7 barrels of oil equivalent (BOE)
1 TOE = 1.5 tons of coal equivalent (TCE)

The previous consideration does not imply that each country may not continue expressing its balances in the units which, due to tradition or convenience, prove to be more appropiate.

Furthermore, in order to complete the homogeneity of the different sources and forms of energy, the following premises should be taken into account:

7.2 Treatment of Hydroenergy

For the presentation of hydroenergy in the OLADE format, the theoretical criterion has been adopted, which if, indeed, it ensures the coherence of the balance as a whole, it tends to underestimate the participation of hydroenergy among other primary sources. It should be pointed out that the opposite problem occurs in the case of firewood, and this form of energy appears to be overestimated with respect to the others; but this problem, despite its importance, has not attained such a polemical character as has the case of hydroenergy. It is also recommended that the figures resulting from the use of the caloric criterion be noted in the part corresponding to observations.

7.2.1 Theoretical Criterion

In accordance with this criterion, the production of hydraulic energy in a plant is evaluated by means of the following formula:

$$HE = gtH\ (Q_1 + Q_2) \qquad \text{(Kwhr)}$$

Where:

= Water density in kg/m^3
g = Gravity acceleration in m/sec^2
t = Operational time in plant, in hrs/yr
H = Height of fall in meters
Q_1 = Turbined quantity in m^3/sec
Q_2 = Spilled quantity in m^3/sec

With regard to the hydraulic energy that feeds the transformation centers, the same formula is applied, but only for the turbined flux, while the spilled flux defines the unutilized energy.

It is useful to note that in those cases where only the amount of electric energy 1/ available in the exit is known, the transformed primary energy may be calculated by means of the approximate formula:

$$HE = \frac{E}{\quad}$$

Where:

HE = Hydroenergy in kwhr/yr
E = Electricity in kwhr/yr
= Average yield of a hydro power station, approximately 0.8

7.2.2 Caloric Criterion

In accordance with this criterion, hydroenergy is transformed considering the caloric amount of the fuel necessary for the production of 1 kw-hr in the thermal plants of each country, and the electricity, as secondary energy, considering the caloric conversion coefficient; in other words:

$$1 \text{ kw-hr} = 8.6 \times 10^{-5} \text{ TOE}$$

The choice of such an equivalency coefficient for hydroenergy provides a better link to development strategy and permits better utilization of the energy resources, given that hydroenergy is no longer underestimated with

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1/ This procedure obviously does not permit knownledge of the unutilized energy.

respect to the other resources. In this way, its participation in the primary energy structure is in accord with the great effort that an increase in the utilization of the hydroenergy potential represents for many countries.

For calculating the transformation coefficient for hydroenergy, the average specific consumption of each country's conventional power plants should be used.

7.3 Treatment of Geoenergy

For the case of geoenergy, the same methodology as that put forth for hydroenergy is considered; that is to say that the production of primary energy of geothermal origin will be defined by the enthalpy contained in the mass of steam and water extracted from the deposit, minus that corresponding to the mass of steam and water that can be reinjected.

7.4 Treatment of Firewood (See Chapter 6)

7.5 Treatment of the Calorific Power of Solid, Liquid, and Gaseous Fuels

The solid, liquid, and gaseous fuels are evaluated according to their lower calorific power, which discounts the condensation of the water vapor contained in combustion gases, which cannot be used in practice.

The non-energy oil products, such as lubricants, asphalt, grease, and solvents, can be evaluated at the same calorific power of the oil that gives them origin.

In each balance, it is useful to include information corresponding to the lower calorific power of all of the primary resources and the secondary energy forms (Chart N° 7), as well as the conversion factors for going from the units used in each country to the common unit (Chart N° 8). The average conversion factors, recommended for use when such information does not exist, are presented in Chart N° 9.

Chart Nº 7

TABLE OF CALORIFIC POWERS AND AVERAGE DENSITIES

PRODUCTS	DENSITY		LOWER CALORIFIC POWER		
	TON/m^3	Kg/Bl	Kcal/Kg	Kcal/Bl	Kcal/m^3
1.- COAL					
2.- FIREWOOD					
3.- AGRICULTURAL/LIVESTOCK RES.					
4.- CATTLE MANURE					
5.- AGRO-INDUSTRIAL RESIDUES					
6.- URBAN RESIDUES					
7.- CRUDE OIL					
8.- FREE NATURAL GAS					
9.- ASSOCIATED GAS					
10.- COKE					
11.- CHARCOAL					
12.- LIQUIFIED GAS					
13.- AUTOMOTIVE GASOLINE					
14.- AVIATION GASOLINE					
15.- NATURAL GASOLINE					
16.- DOMESTIC KEROSENE					
17.- INDUSTRIAL KEROSENE					
18.- TURBO FUELS					
19.- DISTILLATES					
20.- HEAVY FUELS					
21.- FURNACE GAS					
22.- COKE GAS					
23.- GAS FOR GASOGENES					
24.- DISTRIBUTED GAS					
25.- REFINERY GAS					
26.- ETHYL ALCOHOL					
27.- NON-ENERGY DERIVATIVES					

Chart N° 8

CONVERSION FACTORS

PRODUCT	CONVERSION FACTOR	CONVERSION FACTOR
1.- COAL	TOE/TON	——
2.- FIREWOOD	TOE/TON	TOE/M^3
3.- AGRICULTURAL/LIVESTOCK RES.	TOE/TON	TOE/M^3
4.- CATTLE MANURE	TOE/TON	TOE/M^3
5.- AGRO-INDUSTRIAL RESIDUES	TOE/TON	TOE/M^3
6.- URBAN RESIDUES	TOE/TON	TOE/M^3
7.- CRUDE OIL	TOE/BI	TOE/TON
8.- FREE NATURAL GAS	TOE/1000 FT^3	TOE/1000 M^3
9.- ASSOCIATED GAS	TOE/1000 FT^3	TOE/1000 M^3
10.- COKE	TOE/TON	——
11.- CHARCOAL	TOE/TON	——
12.- LIQUIFIED GAS	TOE/BI	TOE/TON
13.- AUTOMOTIVE GASOLINE	TOE/BI	TOE/TON
14.- AVIATION GASOLINE	TOE/BI	TOE/TON
15.- NATURAL GASOLINE	TOE/BI	TOE/TON
16. DOMESTIC KEROSENE	TOE/BI	TOE/TON
17.- INDUSTRIAL KEROSENE	TOE/BI	TOE/TON
18.- TURBO FUELS	TOE/BI	TOE/TON
19.- DIESEL OIL	TOE/BI	TOE/TON
20.- HEAVY FUELS	TOE/BI	TOE/TON
21.- FURNACE GAS	TOE/1000 M^3	——
22.- COKE GAS	TOE/1000 M^3	——
23.- GAS FOR GASOGENES	TOE/1000 M^3	——
24.- DISTRIBUTED GAS	TOE/1000 FT^3	TOE/1000 M^3
25.- REFINERY GAS	TOE/1000 FT^3	TOE/1000 M^3
26.- ETHYL ALCOHOL	TOE/BI	TOE/M^3
27.- NON-ENERGY DERIVATIVES	TOE/TON	TOE/BI
28.- ELECTRIC ENERGY	TOE/MWh	——

EXAMPLES OF CONVERSION FACTORS

PRODUCT	CONVERSION FACTOR (1)	CONVERSION FACTOR (2)
1.- COAL	0.700 TOE/TON	——
2.- FIREWOOD	0.360 TOE/TON	——
3.- CRUDE OIL	0.139 TOE/BI	1.020 TOE/TON
4.- FREE NATURAL GAS	0.0235 TOE/1000 FT^3	0.830 TOE/1000 M^3
5.- ASSOCIATED GAS	0.0252 TOE/1000 FT^3	0.890 TOE/1000 M^3
6.- COKE	0.680 TOE/TON	——
7.- CHARCOAL	0.690 TOE/TON	——
8.- LIQUIFIED GAS	0.093 TOE/BI	1.08 TOE/TON
9.- AUTOMOTIVE GASOLINE	0.124 TOE/BI	1.05 TOE/TON
10.-AVIATION GASOLINE	0.119 TOE/BI	1.05 TOE/TON
11.- NATURAL GASOLINE	0.106 TOE/BI	1.06 TOE/TON
12.-KEROSENE	0.133 TOE/BI	1.03 TOE/TON
13.-TURBO FUELS	0.136 TOE/BI	1.04 TOE/TON
14.-DIESEL OIL	0.139 TOE/BI	1.02 TOE/TON
15.-HEAVY FUELS	0.143 TOE/BI	1.00 TOE/TON
16.- FURNACE GAS	0.090 TOE/1000 M^3	——
17.- COKE GAS	0.420 TOE/1000 M^3	——
18.- DISTRIBUTED GAS	0.0113 TOE/1000 FT^3	0.400 TOE/1000 M^3
19.- REFINERY GAS	0.0311 TOE/1000 FT^3	1.100 TOE/1000 M^3
20.-ETHYL ALCOHOL	0.083 TOE/BI	0.52 TOE/ M^3
21.- NON-ENERGY DERIVATIVES	0.99 TOE/TON	0.139 TOE/BI
22.-ELECTRIC ENERGY	0.086 TOE/MWh	——

8. ANALYSIS OF THE RESULTS

Once the historical series of balances has been realized and the concrete results have been presented in the adopted format, the next step is to analyze the elaborated information.

The analysis must confront the study of the national energy system's evolution, in absolute as well as relative values.

The energy balance in itself does not contain all of the elements which are sufficient to analyze the system as a whole. It is necessary to possess other information, especially on:

- The country's energy resources
- The circumstance foreign to the sector but which, in some way, condition the energy production (political, international, technological aspects, etc.).
- The general production of goods and services and its organization.

In effect, the demand for energy by the different consumption sectors is determined by:

- The requirements for industrial and agricultural/livestock production, by means of technical options in the production system.
- The requirements for final consumption through the social behavior of the consumers.

In order to use the energy balance as an effective tool, it is necessary to be aware of certain non-energy indicators characteristic to the different economic activities. The energy system can only be fully defined to the extent that its place within the socio-economic situation is fully known.

The energy balances are used as an instrument of analysis in planning the energy sector.

For the management of the energy system, the balance should provide the possibility of establishing certain criteria with respect to the "effectiveness" of this system:

- Be that in the strict sense of energy effectiveness or
- Be it associated with economic information, in a more general sense of economic effectiveness.

At a microeconomic level, the decisions in an energy production or transformation unit are made within a restricted framework, and the balance will hardly be useful due to the degree of its breakdown.

At a macroeconomic level, the problems of resource distribution in production activities are somewhat cleared up by the energy balance. In it, indispensable information is made available for undertaking the optimal distribution of resources.

In general, within a short-term perspective, the balance permits knowledge of the different energy alternatives (favoring this or that form of energy), according to the final use in the large consumer categories. In addition it permits the establishment of the relationship between the final demand and the primary energy natural resources.

Within a long-range perspective, the balance is an indispensable tool for forecast and planning. Forecasts are supported by the pre-established tendencies or determinations, while planning needs options and precise political and economic measures. This long-range planning seeks to satisfy the demand for energy at a lower cost, considering other social objectives, and also taking into account the known primary energy resources.

The analysis of the balances is an indispensable step in the process described previously, and it may be carried out as indicated below.

8.1 Analysis of the Primary Energy Supply

The evolution of the different components of the Total Primary Supply (Rows 1, 2 and 3) must be observed, calculating the annual growth rates for each source or product and for the total during the period unber study.

Likewise, the relationship between national production and importation will give an idea of the degree of energy self-sufficiency.

The Gross Internal Supply should be analyzed in the same way as is the Total Primary Supply.

The evolution of exports will illustrate the behavior of this activity in the gross internal supply balance. It is important to observe the evolution of unutilized energy (Row 6) and to compare it with that of production.

Also, the production variation must be analyzed for each one of the products, and whether it diminishes or increases the unutilized amount in each one.

The overall behavior of the supply must definitely be analyzed.

It is particularly interesting to consider the ratio in which hydrocarbons participate in the energy supply. Also, whenever possible, the structure of the supply should be compared with that of the reserves, in order to appreciate the degree of correspondence between the two.

8.2 Analysis of the Energy Sector

In this part of the balance, it deserves special interest to observe the modifications that have taken place with regard to the intake of the transformation centers, their production structure, and the corresponding transformation losses.

It is recommended that each one of the transformation centers included in the balance be studied separately. It is important to point out that the power plants and refineries constitute the principal stages of the primary and/or secondary energies process of transformation into other sources, more versatile and adaptable to the market's requirements.

With respect to the power plants, there are the public service ones and the ones for self-use. Great interest lies in comparing their production and drawing pertinent conclusions within the framework of each nation's particular situation.

Given that the power plants can be of different natures, such as hydraulic, geothermal, nuclear, conventional steam or internal combustion and gas turbine, each one's participation in the total production must be analyzed; in this way, the generating structure will be manifested according to the sources of origin. In the programs for new installations, this framework will aid in elaborating a policy for substituting the more abundant energy sources for those less available.

Similarly, the transformation center's losses must be analyzed in depth, since these can increase as a function of an increase in the generation of electricity with less efficient equipment, such as gas turbines.

It is also recommended that the internal structure of the refineries be analyzed, comparing it with the consumption of oil products, with the purpose of determining if the refining equipment does or does not respond to the market configuration.

In concluding the analysis of the energy sector, it is important to study each sector's efficiency independently, as well as the whole system's global efficiency, including production, transformation, transportation, distribution, and storage. In general, these efficiencies can be calculated as the relation of total losses plus the consumption over the total of the secondary energy produced.

On analyzing the total supply of secondary energy, the percentage of national production or importation needed to satisfy it is made manifest.

An examination of the gross internal supply reveals the percentages of the total supply destined to be exported.

8.3 Analysis of the Final Consumption

The total final consumption appears in the last part of the balance's presentation, where its composition and that of the final energy consumption (Rows 12.1 and 12.2) can be examined product by product.

First, the evolution of each source or product must be observed for the period under analysis.

The most important analysis is that of the evolution of the final energy consumption's structure, for each one of the chosen consumption sectors (Rows 12.2.1 through 12.2.5); the most dynamic sectors and their determining causes should be analyzed.

Moreover, it is recommended that the results of the final energy consumption's evolution be analyzed product by product in each sector. In this way it is possible to visualize the substitutions made among them and to deduce the causes.

8.4 Relationship between Energy and Economic Growth

An awareness of the energy sector's evolution and composition permits the making of a correlation with the macroeconomic variables; in this way it is possible to analyze this sector's behavior and that of the economy as a whole.

It is very useful to relate the total energy consumption and the electric consumption to the gross internal product, and it is also important to correlate the total energy consumption and the electric consumption with the corresponding gross internal product structure, by sector. The following are some of the indicators, among others:

- Elasticity in total energy consumption - gross internal product.
- Elasticity in electric energy consumption - gross internal product.
- Total energy consumption per unit of the gross internal product.
- Electric energy consumption per unit of the gross internal product.
- Relationship between commercial and non-commercial energy.

In addition to the foregoing parameters, an awareness of the sector's evolution will at the same time permit the determination of its relationship to population growth, thus obtaining other parameters for this case (per capita energy consumption) which, analyzed together with the other indicators, will, to some extent, permit the determination of the degree of development achieved by the country and will provide adequate elements for the study of the energy sector's historical evolution and prospects. In the latter case, the energy consumption for each branch of the economy and each future period may be considered in correlation with the chosen indicators.

APPENDIX A

NOMENCLATURE

.1 NOMENCLATURE: GENERAL STRUCTURE OF THE BALANCE (ROWS)

NAME	CODE
SUPPLY	OFE
PRIMARY ENERGY PRODUCTION	PEP
IMPORTATION OF PRIMARY ENERGY	IMP
PRIMARY ENERGY INVENTORY VARIATION	VIP
INITIAL PRIMARY EXISTENCE	EIP
FINAL PRIMARY EXISTENCE	EFP
TOTAL PRIMARY SUPPLY	OTP
EXPORTATION OF PRIMARY ENERGY	EXP
UNUTILIZED PRIMARY ENERGY	NAP
GROSS PRIMARY SUPPLY	OBP
PRIMARY LOSSES	PER
PRIMARY'S OWN CONSUMPTION	CPP
FINAL PRIMARY CONSUMPTION	CFP
PRIMARY INPUT	ENP
ENERGY SECTOR	SEN
TRANSFORMATION CENTERS	CTR
COKE PLANTS AND FURNACES	COQ
COKE PLANTS	CAR
BIOMASS	BIO
ANAEROBIC DIGESTERS	DIA
ETHYL ALCOHOL DESTILLERIES	DAE
GASOGENES	GAS
REFINERIES	REF
GAS TREATMETS PLANTS	PTG
PUBLIC SERVICE POWER PLANTS	CEP
SELF-US POWER PLANTS	CEA
PLANTS FOR ELABORATION OF NUCLEAR FUELS	PCN
GROSS SECONDARY PRODUCTION	PSB
IMPORTATION OF SECONDARY ENERGY	IMS
SECONDARY ENERGY INVENTORY VARIATION	VIS
FINAL SECONDARY EXISTENCE	EFS
INITIAL SECONDARY EXISTENCE	EIS
TOTAL SECONDARY SUPPLY	OTS
UNUTILIZED SECONDARY ENERGY	NAS
EXPORTATION OF SECONDARY ENERGY	EXS
GROSS SECONDARY SUPPLY	OBS
SECONDARY'S OWN CONSUMPTION	CPS
TRANSFORMATION LOSSES	PET
SECONDARY LOSSES	PES
STATISTICAL ADJUSTMENTS	AES
SECONDARY INPUT	ENS
FINAL SECONDARY CONSUMPTION	CFS
TOTAL FINAL CONSUMPTION	CFT
FINAL NON-ENRGY CONSUMPTION	CFN
FINAL ENERGY CONSUMPTION	CFE
CONSUMPTION SECTORS	SEC
RESIDENTIAL, COMMERCIAL AND PUBLIC	RCP
TRANSPORTATION	TRA
AGRICULTURAL/LIVESTOCK	AGR
INDUSTRIAL	IND
UNIDENTIFIED CONSUMPTION	CNI

[illegible] AND PRODUCTS (COLUMNS)

NAME	CODE	EQUIVALENT TERMS
PRIMARY ENERGY	**EP**	
COAL	CM	
FIREWOOD	LE	
OTHER PLANT AND ANIMAL FUELS ANIMAL FUELS	OC	
AGRICULTURAL/LIVESTOCK RESIDUES	RA	Coffee and rice husks
CATTLE RESIDUES	RP	Manure
FOREST RESIDUES	RF	Saw-mill, shavings, sawdust
AGRO-INDUSTRIAL RESIDUES	RAI	Sugar cane bagasse
URBAN RESIDUES	RU	
ENERGY PLANTATIONS	PL	
CRUDE OIL	PT	
FREE NATURAL GAS	GN	Natural gas
ASSOCIATED GAS	GA	
HYDROENERGY	HE	
NUCLEAR ENERGY	NE	
GEOENERGY	GE	
FISSION FUELS	CF	
NATURAL URANIUM	UN	
ENRICHED URANIUM	UE	
SECONDARY ENERGY	**ES**	
COKE	CQ	
CHARCOAL	CV	
LIQUIFIED GAS	GL	Comercial propane, supergas, propane-butane, LPG, liquid gas
GASOLINES AND NAPHTHAS	GO	
COOKING GASOLINE	GC	Regular gas
NATURAL GASOLINE	GNN	Natural gasoline
AUTOMOTIVE GASOLINE	GM	Motor gas, regular automotive gas, common naphtha common benzine, extra automotive gasoline, special automotive gasoline, extra or special bencine, naphtha, petronaphtha
AVIATION GASOLINE	GV	Aero-naphtha
KEROSENE AND TURBOFUEL	KE	Kerex, JPI, JETAI, JPZ, Turbonaphtha
DESTILLATES	DE	Automotive fuel oil, disel fuel, disel oil, petrodisel, ACPM.
HEAVY FUELS	CP	Combustoleo, fuel oil, bunker C, industrial oil, residual oil, residue oil.
OTHER ENERGY FUELS	OE	
ETHYL ALCOHOL	AE	Carbon-hydrate alcohol, anhydrous alcohol
REFINERY COAL	CR	Residual oil coal, oil coke.
NON-ENERGY PRODUCTS	PN	
LUBRICANTS (OILS)	AL	
GREASE	LU	
ASPHALT	AS	
SOLVENTS	SO	
GAS	GS	
DISTRIBUTED GAS	GD	
REFINERY GAS	GR	
FURNACE GAS	GH	
COKE GAS	GQ	
GAS FOR GASOGENES	GG	
ELECTRIC POWER	EE	

A. 3.- GENERAL NOMENCLATURE

NAME
1 - AGRICULTURAL / LIVESTOCK
2.- AGRICULTURAL / LIVESTOCK RESIDUES
3.- AGRO-INDUSTRIAL RESIDUES
4.- ANAEROBIC DIGESTERS
5.- ASSOCIATED GAS
6.- ASPHALT
7 - AUTOMOTIVE GASOLINE
8.- AVIATION GASOLINE
9.- BIOMASS
10.- CATTLE RESIDUES
11.- COKE PLANTS AND FURNACES
12.- COAL PLANTS
13.- CONSUMPTION SECTORS
14 - COAL
15.- COKE
16.- COOKING GASOLINE
17.- COKE GAS
18.- CRUDE OIL
19.- CHARCOAL
20.- DISTILLATES
21.- DISTRIBUTED GAS
22 - ELECTRIC POWER
23 - ELECTRICAL PLANTS
24 - ENERGY PLANTATIONS
25 - ENRICHED URANIUM
26 - ENERGY SECTOR
27.- ETHYL ALCOHOL DISTILLERIES
28.- ETHYL ALCOHOL
29.- EXPORTATION OF SECONDARY ENERGY
30.- EXPORTATION OF PRIMARY ENERGY
31.- FINAL PRIMARY EXISTENCE
32.- FINAL PRIMARY CONSUPTION
33.- FINAL PRIMARY DESTINATION
34.- FINAL SECONDARY EXISTENCE
35.- FINAL SECONDARY CONSUPTION
36.- FINAL NON-ENERGY CONSUPTION
37.- FINAL ENERGY CONSUPTION
38.- FIREWOOD
39.- FISSION FUELS
40.- FREE NATURAL GAS
41.- FOREST RESIDUES
42.- FURNACE GAS
43.- GASOGENES
44.- GAS TREATMENT PLANTS
45.- GASOLINES AND NAPHTHAS
46.- GAS
47.- GAS FOR GASOGENES

(ALPHABETICAL ORDER)

CODE	NAME	CODE
AGR	51.- GROSS PRIMARY SUPPLY	OBP
RA	52.- GROSS SECONDARY PRODUCTION	PSB
RAI	53.- GREASE	LU
DIA	54.- HEAVY FUELS	CP
GA	55.- HYDROENERGY	HE
AS	56.- IMPORTATION OF PRIMARY ENERGY	IMP
GM	57.- IMPORTATION OF SECONDARY ENERGY	IMS
GU	58.- INITIAL PRIMARY EXISTENCE	EIP
BIO	59.- INITIAL SECONDARY EXISTENCE	EIS
RP	60.- INDUSTRIAL	IND
COQ	61.- LIQUIFIED GAS	GL
CAR	62.- LUBRICANTS (OILS)	AL
SEC	63.- KEROSENE AND TURBO FUEL	KE
CM	64 - NATURAL URANIUM	UM
CQ	65.- NATURAL GASOLINE	GNN
GC	66.- NON-ENERGY	NE
GQ	67 - NUCLEAR ENERGY	NE
PT	68.- OTHER PLANT AND ANIMAL FUELS	OC
CV	69.- OTHER ENERGY FUELS	OE
DE	70.- PLANTS FOR ELABORATION OF NUCLEAR FUELS	PCN
GD	71.- PRIMARY INPUT	ENP
EE	72.- PRIMARY ENERGY	EP
CEL	73.- PRIMARY ENERGY PRODUCTION	PEP
PL	74.- PRIMARY ENERGY INVENTORY VARIATION	VIP
UE	75.- PRIMARY LOSSES	PER
ENP	76.- PRIMARY'S OWN CONSUPTION	CPP
DAE	77.- REFINERIES	REF
AE	78.- RESIDENTIAL, COMMERCIAL, AND PUBLIC	RCP
EXS	79.- REFINERY COAL	CR
EXP	80.- REFINERY GAS	GR
EFP	81.- SELF-USE POWER PLANTS	CEA
CFP	82.- SECONDARY'S OWN CONSUPTION	CPS
DFP	83.- SECONDARY LOSSES	PES
EFS	84 - SECONDARY INPUT	ENS
CFS	85 - SECONDARY ENERGY	ES
CFN	86.- SECONDARY ENERGY INVENTORY VARIATION	VIS
CFE	87.- SOLVENTS	SO
LE	88.- STATISTICAL ADJUSTMENTS	AES
CF	89. SUPPLY	OFF
GN	90.- TOTAL PRIMARY SUPPLY	OTP
RF	91.- TOTAL SECONDARY SUPPLY	OTS
GH	92.- TOTAL FINAL CONSUPTION	CFT
GAS	93.- TRANSFORMATION CENTERS	CTR
PTG	94.- TRANSFORMATION LOSSES	PET
GO	95.- TRANSPORTATION	TRA
GS	96.- UNUTILIZED PRIMARY ENERGY	NAP
GG	97.- UNIDENTIFIED CONSUPTION	CNI

APPENDIX B

TREATMENT OF THE SURVEY RESULTS

B.1 Treatment of the Statistical Information from the Firewood Survey

When it cannot be assumed that the concept (X) - People-meal/day- is constant, knowing that when the number of people - meal increases, then obviously the duration of the energy unit is reduced; therefore, the following function should be investigated:

$$Y = AX^{\alpha}$$

Where:

Y = Duration, in days, of the adopted unit, for a family.

X = Number of people-meal/day.

A = Constant

α = Regression parameter; $-1 < \alpha < 0$

The correlation cannot be made directly, but rather by dividing the sample into sub-samples, taking equal intervals for (X) and calculating the average duration of (Y) within each interval. During this process, the points which are excessively distant from the mean should be rejected; but in no case should the rejection exceed 10% of the total number of points in the sample.

(X) generally varies between 3 and 40, and between 10 and 15 intervals may be taken. If the sample is well taken and the calculations are well done, a fitting above 90% should be expected; the large amount of samples taken in Peru, Ecuador, and the Central American countries have invariably responded to this pattern. If the fitting is not good, it is a sign that some undetected problem (for instance, units, fuel mixutres, etc.) is affecting the quality of the results.

If the fitting is better than 90%, G(X) and G(Y), the geometric means for (X) and (Y), can be calculated. The specific consumption (C) is calculated with the following formula:

$$C = \frac{K}{G(X)\ G(Y)}$$

Where:

C = Specific consumption expressed in kg/person - meal
K = Equivalent of the adopted unit in kg
G(X) and G(Y) = Geometric means previously defined

It should also be clarified that the correlation C = C(X) responds to the function $C = A'X^{\alpha'}$ 1/, with α' being negative and less than 1. This expresses the fact that as the number of people increases, the specific consumption decreases, thereby increasing the efficiency of use in cooking. This correlation can be made as an additional verification and only to corroborate the previous fitting, of which it is a direct consequence. The methodology for estimating the annual national consumption (Q) in kilocalories is identical to that presented in Paragraph 6.2.3.

B.2 Treatment of the Statistical Information from the Special Tests on Industrial Firewood Consumption

The following variables are again defined:

X = Number of product units extracted per burning
Q = Number of burnings done in a year
Y = Amount of firewood, in kg, that is used for each burning
C = Specific consumption in kg/unit

Thus, we have:

$$C = \frac{Y}{X}$$

1/ In effect, if $Y = AX^{\alpha}$ and $C = \frac{K}{XY}$, we can write: $C = \frac{K}{X\ AX^{\alpha}} = A'X^{\alpha'}$

In general, the following relation is complied with:

$$C = AX^{\alpha}$$

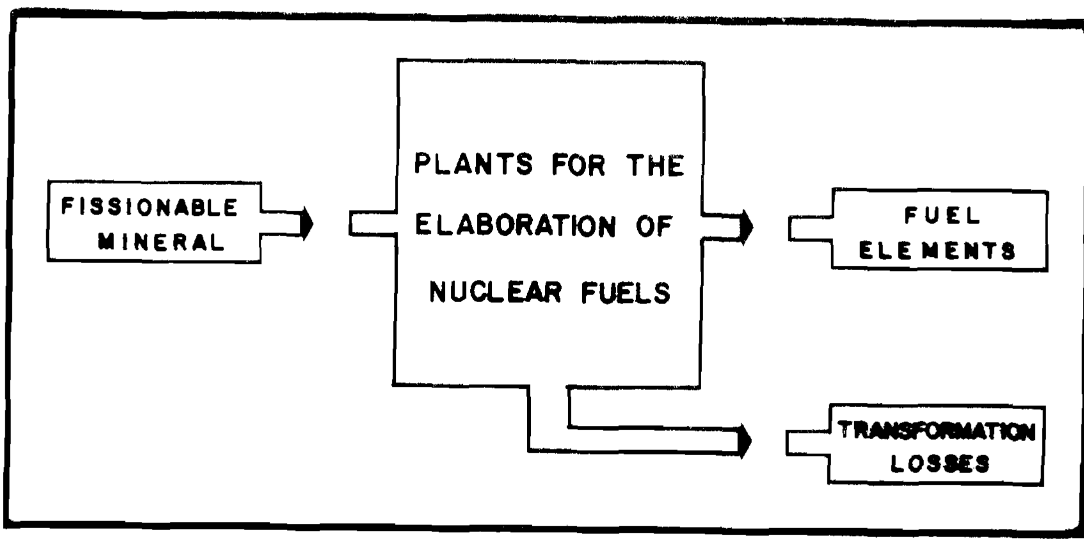
With $-1 < \alpha < 0$, which indicates that the per unit consumption decreases with the increased production per burning. The verification of the previous formula on the basis of the data obtained for each kind of unit corroborates the soundness of the samples taken. It is necessary to formulate a warning: in order to have good fittings, compare installations that use the same technology, which may well be the case for artesanal units, although there may be exceptions.

APPENDIX C

NUCLEAR ENERGY

C.1 Plants for the Elaboration of Nuclear Fuels

Although plants for the elaboration of nuclear fuels do not yet exist in Latin America, it is useful to include the center corresponding to this process, the scheme for which is shown in the following figure:



The process begins with the extraction of uranium, which, free from impurities, is concentrated, obtaining U_3O_8. This then passes to a purification stage, where UO_3 or pure U_3O_8 is obtained.

From the latter stage, it passes to a conversion plant where UO_2 oxide is produced; from this product on, the process becomes differentiated according to the type of reactor used by the nuclear fuel.

For the reactors cooled by natural uranium gas (GCR), the UO_2 is fluoridated and reduced to obtain metallic uranium, with which the fuel elements are manufactured.

For the heavy water reactors (HWR) for natural uranium, the UO_2 is transformed into ceramic grade UO_2, with which the fuel elements are manufactured.

For the pressurized water or boiling water reactors (BWR) for enriched uranium, the UO_2 undergoes a fluoridation process to obtain uranium hexafluoride (UF_6); this is treated in a gaseous diffusion or centrifugate plant, from which enriched uranium, such as UF_6, is obtained. The process is continued with a conversion plant which produces enriched UO_2 oxide, with which the fuel elements are manufactured.

The different fuel elements obtained are used in the respective reactors to produce steam, which finally activates the turbine and the alternator as in a conventional plant, which is separately treated with the power plants.

C.2 Treatment of Nuclear Energy

In a case where a country should like to include nuclear energy in its balance, it is recommended that a criterion similar to that established for hydroenergy be adopted, that is to say, the production of primary nuclear energy will be equal to the amount of heat obtained from the fission fuel on being "burned" in a reactor. The following is put forth for reference:

a. The caloric equivalent for 1 ton of natural uranium, enriched to 3% and "burned" in a PWR reactor of 30,000 MWD is: 1 ton nat. U = 4.24×10^{10} J. 1/

b. The caloric equivalent of 1 ton of natural uranium utilizable in a 7500 MWD HWR reactor is: 1 ton nat. U = 6.48×10^{14} J 1/

1/ Taken from Charpentier, Jean Pierre. International Energy Agency, Vienna.

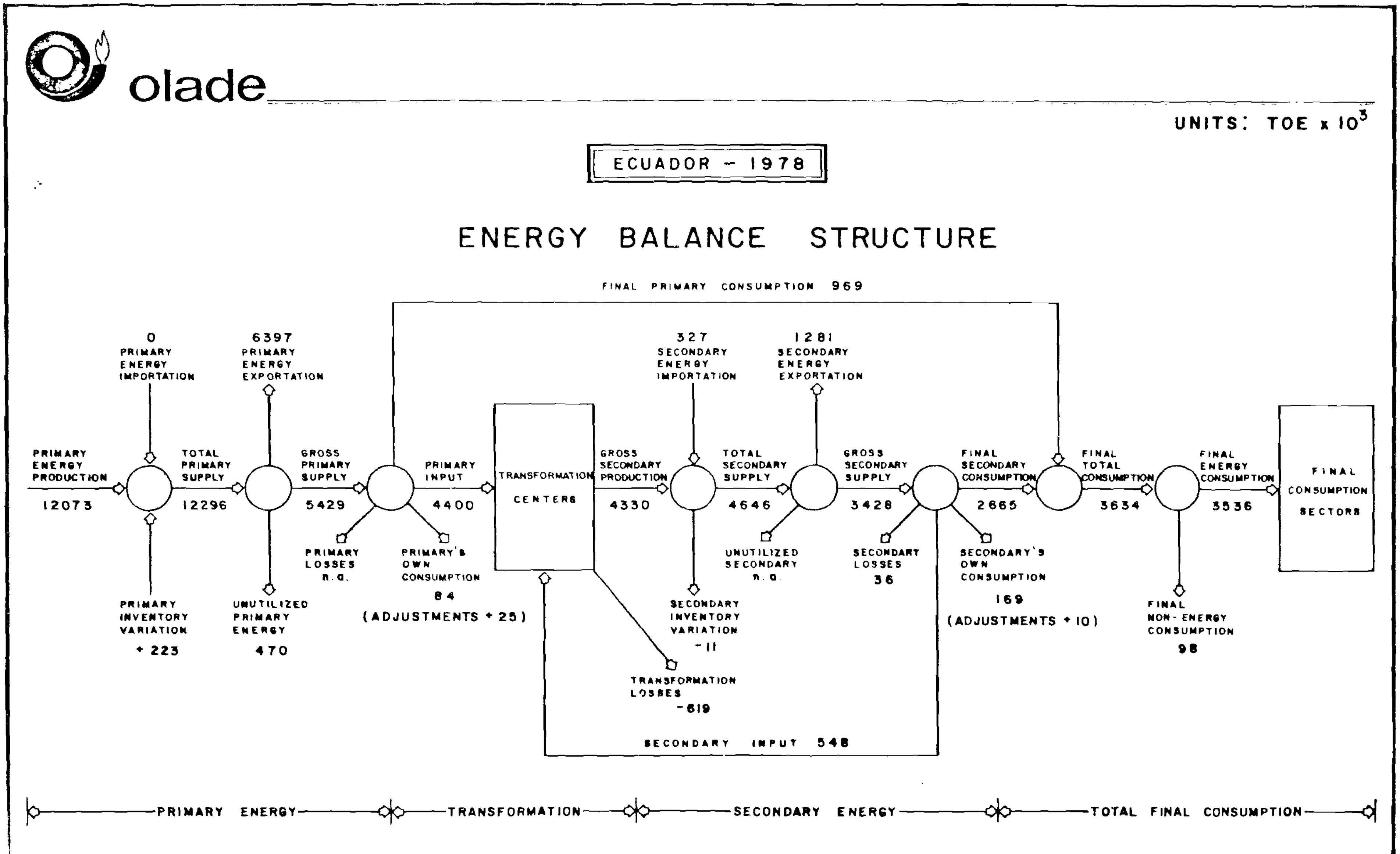
APPENDIX D

EXAMPLES

D.1 Energy Balances from Ecuador

D.2 Energy Balances from Peru

D.1.- EXAMPLE: ENERGY BALANCE FROM ECUADOR - FIGURE 1



olade

CONSOLIDATED ENERGY BALANCE

UNITS: TOE x 10^3 — YEAR: 1978

COUNTRY: ECUADOR

MINISTRY: NATURAL RESOURCES

ELABORATED BY: NATIONAL ENERGY INSTITUTE

PLACE: QUITO — DATE: SEPT. 1980

			PRIMARY ENERGY										SECONDARY ENERGY												
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
			Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hidroenergy	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECONDARY ENERGY	TOTAL
ENERGY SECTOR	SUPPLY	1	Production		783	186	10582		447	75			12073													12074
		2.	Importation													9	162	39	56			61			327	327
		3.	Inventory Variation				+225						+223			-1	+11	-44	-2	+25					-11	+212
		4	TOTAL SUPPLY		783	186	10805		447	75			12296			8	173	-5	54	25		61			316	12612
		5	Exportation				-6397						-6397						-7	-1211					-1218	-7615
		6	Unutilized				-62		-408				-470													-470
		7	GROSS INTERNAL SUPPLY		783	186	4346		39	75			5429			8	173	-5	47	-1186		61			-902	4527
	TRANSFORMATION CENTERS	8.	TOTAL TRANSFORMATION				-4314		-12	-75			-4401			+68	+891	+361	+529	+1674		+37		+223	+3783	-618
		8.1	Coke Plants, Furnaces																							
		8.2	Coal Plants																							
		8.3	Biomass																							
		8.4	Refineries				-4314						-4314			+66	+883	+499	+695	+1917		+37			+4097	-217
		8.5	Gas Plants						-12				-12			+2	+8								+10	-2
		8.6	Public Service Power Plants							-72			-72					-139	-113	-239				+202	-289	-361
		8.7	Self-Use Power Plants							-3			-3						-52	-4				+21	-35	-38
		9	Energy Sector's Own Consump.				-57		-27				-84			-1	-6	-5	-18	-133				-6	-169	-253
		10	Losses (Transp. Distri. Storage)													-2	-3	-1		-1				-29	-36	-36
		11	ADJUSTMENTS				+25						+25			-2	-18	-1	-33	+45					-9	+16
FINAL CONSUMPTION		12.	TOTAL FINAL CONSUMPTION		783	186							969			71	1036	349	525	398		98		188	2665	3634
		12.1	Final Non-Energy Consumption																			98			98	98
		12.2	Final Energy Consumption		783	186							969			71	1036	349	525	398				188	2567	3536
		12.2.1	Residential, Commercial, Public		783								783			69	81	201						130	481	1264
		12.2.2	Transportation														955	111	273	178					1514	1514
		12.2.3	Agricultural / Livestock																158						158	158
		12.2.4	Industrial			186							186			2		37	80	223				54	396	582
		12.2.5	Unidentified Consumption																14					3	17	17

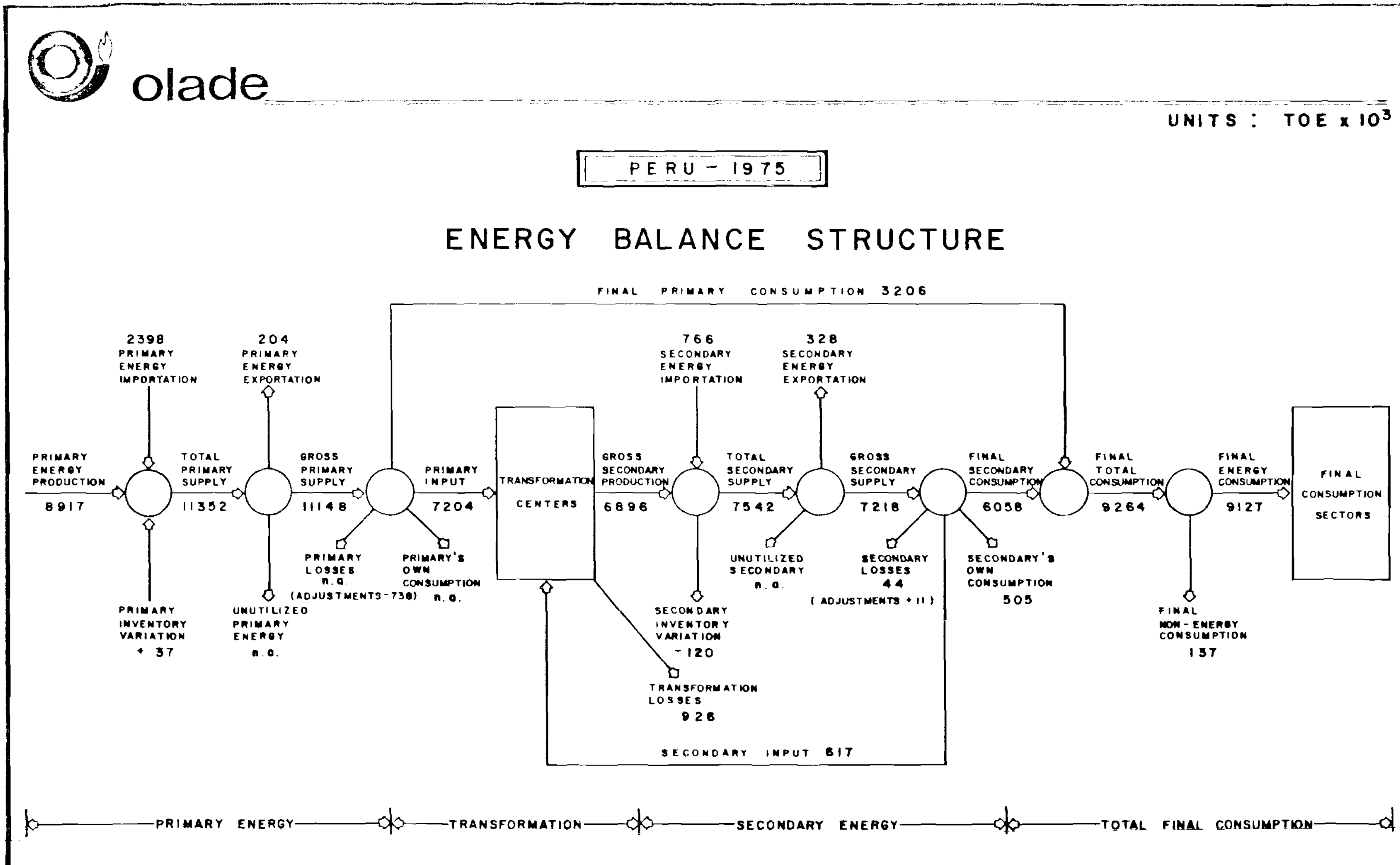
TRANSFORMATION LOSSES

Observations:

	11	12	13	14	15	16	17	18	19	20	21	22
GROSS SECONDARY ENERGY PRODUCTION			68	891	499	695	1917		37		223	4330

OTHERS:

D.2.- EXAMPLE : ENERGY BALANCE FROM PERU - FIGURE 1



n.a. = not available

6.2.- EXAMPLE ENERGY BALANCE FROM PERU - FIGURE Nº 2

olade

UNITS: TOE x 10^3 — CONSOLIDATED ENERGY BALANCE — YEAR: 1975

COUNTRY: PERU

MINISTRY: ENERGY AND MINES

ELABORATED BY: OLADE

ACCORDING TO NATIONAL ENERGY BALANCE

PLACE: QUITO DATE: SEPT. 1980

			PRIMARY ENERGY										SECONDARY ENERGY												
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
			Coal	Firewood	Other Plant Animal Fuels	Crude Oil	Free Natural Gas	Associated Gas	Hidroenergy	Geoenergy	Fission Fuel	TOTAL PRIMARY ENERGY	Coke	Charcoal	Liquified Gas	Gasolines / Naphthas	Kerosene and Turbo Fuel	Diesel and Gas Oil	Heavy Fuels	Other Energy Fuels	Non-Energy Products	Gas	Electricity	TOTAL SECONDARY ENERGY	TOTAL
ENERGY SECTOR — SUPPLY	1.	Production	16	2868	691	3629		1125	588			8917													8917
	2.	Importation	33			2365						2398	149		5	68	150	174	172		48			766	3164
	3.	Inventory Variation				37						+ 37	-30		-1	-17	-2	-12	-54		-4			-120	-83
	4.	TOTAL SUPPLY	49	2868	691	6030		1125	588			11351	119		4	51	148	162	118		44			646	11997
	5.	Exportation				-204						-204			-10	-1		-16	-301					-328	-533
	6.	Unutilized																							
	7.	GROSS INTERNAL SUPPLY	49	2868	691	5826		1125	588			11147	119		-7	50	149	149	-182		44			322	11469
TRANSFORMATION CENTERS	8.	TOTAL TRANSFORMATION	-20	-289	-88	-5688		-531	-588			-7204	-85	+116	+127	+1564	+870	+804	+1615		+68	+557	+644	6280	-924
	8.1.	Coke Plants, Furnaces	-20									-20	-85(*)									+39		-46	-66
	8.2.	Coal Plants		-289								-289		+116										+116	+173
	8.3.	Biomass																							
	8.4	Refineries				-5688						-5688			+114	+1506	+870	+1003	+1882		+64	+108		+5847	-141
	8.5	Gas Plants						-531				-531			+12	+59					+4	+456		+531	0
	8.6.	Public Service Power Plants			-88				-588			-676						-200	-268			-46	+644	+130	-546
	8.7.	Self-Use Power Plants																							
	9.	Energy Sector's Own Consump.														-3	-4	-17	-72			-407	-2	-505	-508
	10.	Losses (Transp. Distri. Storage)																					-44	-44	-44
	11.	ADJUSTMENTS	-8			-138		-594				-738	-12		-3	+18	-49	-10	+74			-5	-2	+11	-727
FINAL CONSUMPTION	12.	TOTAL FINAL CONSUMPTION	25	2579	602							3206	21	116	117	1629	966	923	1433		111	144	596	6058	9264
	12.1.	Final Non-Energy Consumption			26							26									111			111	137
	12.2.	Final Energy Consumption	25	2579	577							3181	21	116	117	1629	966	923	1435			144	596	5947	9127
	12.2.1	Residential, Commercial, Public		2222	242							2464		116	101	51	626	181	58			102	190	1425	3889
	12.2.2	Transportation														1497	249	397	126					2269	2269
	12.2.3	Agricultural / Livestock			335							335				13	11	53	121				31	229	564
	12.2.4	Industrial	25	357								382	21		16	69	81	292	1130			43	375	2027	2409
	12.2.5	Unidentified Consumption																							

TRANSFORMATION LOSSES

Observations:

	11	12	13	14	15	16	17	18	19	20	21	22
GROSS SECONDARY ENERGY PRODUCTION	19	116	127	1564	870	1003	1882		68	603	644	6896

OTHERS: (*) Coke production +19; Furnace input: -104; Total -85

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