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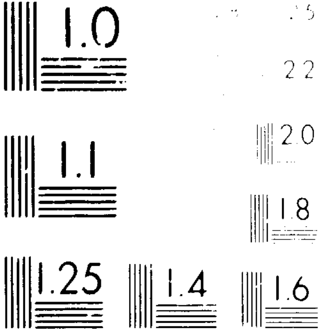
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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

(UNIDO)

Brazil.

ENERGY CONSERVATION AND SUBSTITUTION IN THE BRAZILIAN INDUSTRY .

THE CEMENT AND LIME INDUSTRY

Prepared by Peter Kalas

Energy Consultant to UNIDO

July/August 1983

CONTENTS

1 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

1. The situation in the energy sector of Brazil in last years has been largely characterized by relatively high annual growth rates of energy consumption, particularly also in the industry, large dependence on petroleum imports with an adverse impact on the balance of payment, and relatively low participation of indigeneous energy resources (coal, charcoal, peat, petroleum).

2. The industry, with its share in the total Brazilian energy consumption of nearly 37 %, is the country's most important energy consumer with a high portion of fuel oil use. Thus the current great effort towards a rational use of energy in the industry and substitution of the fuel oil consumption conforms with and is related to the principal targets of the Brazilian energy policy.

3. Within the industrial sector, the cement industry belongs to among the most significant energy consuming subsectors. During 1976 - 1980, the cement production had grown at an average growth rate of 9.2 %/a. In comparison, the respective energy consumption has developed less intensively (4.4 %/a). Thus, the specific energy consumption decreased by 17 %, amounting presently to 5.24 GJ/t. However, the reason for this favourable development lies mainly in the modernization of technological processes. There is still enough room for the energy conservation measures within the cement industry.

Energy Substitution

4. As a part of its Energy Mobilization Program, the government stipulated energy substitution targets, aiming at replacement of the fuel oil used in the industry by the domestic coal. For the cement industry, a 100 % substitution for fuel oil should materialize by the end of 1984.

5. However, given the specific conditions, the technical and economic considerations may impose limits to the ambitious goal towards the energy substitution in the cement industry. Technical limits are related to the use of the low quality coal in that regions, where the siliceous content of the limestone is not compatible with the high percentage of the ash in the domestic coal. Economic limits are related to relatively high production and transportation costs of the Brazilian coal produced in the south, especially to the remote regions in the north. At the moment, significant subsidies are included in current coal prices.

6. Also alternative energy options such as charcoal, peat, natural gas and industrial wastes should be regionally considered for the application as fuel in the cement kilns. However, these energy resources should be analysed in context of the regional and national energy balances and energy developing strategies in order to determine their optimum sectoral and end-use allocation.

   The envisaged full substitution of the fuel oil should also be analysed in view of existing excess of fuel oil in Brazil. At the moment, Brazil exports the available fuel oil at economically inattractive prices. Thus, future national balance of fuel oil should be assessed based on the expected production pattern of the refinery industry and alternative use of fuel oil and petroleum products. Again, relation to national and regional energy plans should be stressed.

7. There is a need to test the use of the low quality coal for various regional characteristics of the limestone in order to determine the technical feasibility and/or limits with regard to the production process of cement. For the testing purpose, installations of an appropriate pilot cement kiln is recommended. The justification of the installation of such a kiln is given, besides the mentioned technological reasons and the energy importance, which the cement industry occupies within the industrial sector, also by the necessity to investigate the alternative options of energy use in the cement industry, such as charcoal, peat, gas, industrial waste, etc. Such tests cannot be performed under normal operating conditions at a cement factory. However, although being installed outside the cement industry, the industry should be directly involved in the investigation and the testing process. The UNIDO can play an active part in participating in both components of the pilot cement kiln: technical assistance and project co-financing.

Energy Conservation

8. As to the energy conservation aspects in the industry, the Mission found an advanced level of information available for some of investigated industries, sufficient technical capacity of personal to carry out the investigation and availabe financial sources for the energy conservation diagnostic program at the level of technological institutes in Sao Paolo and Belo Horizonte. Well functioning appears also the methodical and educational component of the energy conservation program: there exist practical manuals on energy conservation in the most energy intensive industrial subsectors and foreseen is also the program of training courses. The regional energy conservation programs appear to be also well coordinated at the working level. There are periodical meetings of the regional technical staff with the purpose of exchanging experience made in various types of industry. The Secretary of the Industrial Technology (STI) issues a regular journal devoted to the energy conservation and substitution problems.

9. Although the first phase of the energy conservation program, comprising preliminary energy diagnosis and audit, is well in progress, the principal problem is the detailed analysis of technological and energy processes, based on technical measurements. A further detailed investigation is needed in order to define a concrete set of measures and total and specific saving potential at each plant for three principal energy conservation areas: "housekeeping", improvement of existing processes and change of existing processes.

10. For this purpose, installation of three "energy buses" is planned for the year 1984. This program is partly financed by the UNIDO. However, given the regional/geographical characteristic of Brazil and a large number of industries to be investigated (at the first step, the energy conservation program foresees the analysis of 200 of the most important energy consumers and of additional 2,500 industrial energy users), this number of energy vehicles is by far not adequate. Here, an additional financial assistance is needed in order to install at least three more buses. A technical assistance of technological specialists will be also required for short-terms assignments in order to give a special support to the technical staff of energy buses during the first phase.

11. Currently, the saving targets for each sector and industrial plant are administratively defined by the National Petroleum Commission (CNP). There is a lack of a linkage between technical investigations on the rational use of energy on one side, and the CNP targets on the other side.

1.2 RECOMMENDATIONS

12. It is highly desirable to continue the energy conservation and substitution program in the Brazilian industry. In order to further promote the present efficient programs on the energy conservation in the industry it is recommended to prolong the cooperation of the UNIDO (eventually together with another international Agency for Technical Assistance) with the Government of Brazil, represented by the Secretary of the Industrial Technology (STI) in the following fields:

    A) Financing of foreign component of measurement devices and apparatus for further 2 - 3 mobile energy buses.

    B) Providing a short-term Technical Assistance of technological specialists to support the technical staff of the energy buses and/or to train abroad the Brazilian technicians on special aspects of energy conservation.

13. With a special regard to the cement industry, it is recommended to provide:

    C) Financial and Technical Assistance in preparation, planning and construction of a small size pilot cement kiln with the purpose to test the technological feasibility of use of coal and other energy substitution alternatives.

14. It is further recommended to elaborate regional Energy Studies in order to assign regionally and sectorally the domestic energy resources in the most economic way.

1, Preliminary informal contacts to the German Agency for the Technical Cooperation (GTz) indicate an interest in a possible cooperation with the UNIDO in the field of energy conservation in Brazil.

15. A revision and adjustment of the existing targets on a complete substitution of the fuel oil in the cement industry by domestic coal is recommended in view of technical and economical limits. A regional differenciation of substitution targets should be elaborated, accounting also for alternative energy resources to the coal.

16. The energy conservation program should be also in the future given a full financial and administrative support by the government in order to achieve concrete results on the rational use of energy.

2 INTRODUCTION

1. The objective of the UNIDO energy mission to Brazil has been connected with the energy conservation and substitution of petroleum products in the cement and lime industry, which is in line with the principal goals of the national policy.

   During the field mission (between 30.06. - 02.07.1983) the Institutes of Technology in Sao Paulo and Belo Horizonte were visited. Due to special circumstances, the originally scheduled program was adjusted in cooperation between the national counterpart (STI) and the representation of the UNIDO in Brazil.

   Despite the fact that only a part of the original program could be performed, the mission was in a position to define the principal problems in the field of energy conservation and substitution and specify requirements for a further technical and financial assistance. Some suggestions on energy substitution in the cement industry in Minas Gerais were elaborated.

   During the briefing mission in Vienna (06. - 07.07.1983) basic findings, conclusions and recommendations were discussed with the UNIDO offices.

1) For a detailed program of the mission, see Appendice 1

3 CHARACTERISTIC OF ENERGY CONSUMPTION PATTERN

3.1 NATIONAL LEVEL

In the last years, the energy consumption of Brazil has been largely oriented to use of petroleum derivates. They participated in the final energy consumption in 1981 by approximately 36 %. The share of electricity approached 29 %, whereas consumption of firewood made 16 %. Very low was the use of coal with less than 1 %. Also negligible is the share of natural gas (see Table 1):

Table 1: Energy Consumption of Brazil (1981)

Energy Resource	10 toe *	%
Petroleum products	44,589	35.6
Electricity	36,074	28.8
Firewood	20,359	16.3
Steam coal	979	0.8
Natural gas	821	0.7
Charcoal	3,214	2.6
Ethanol	1,947	1.6
Bapgasso	6,897	5.5
Others	10,012	8.1
Total	124,892	100.0

* toe: tons of oil equivalent. 1 toe equals approx. 41.9 GJ.

Source: National Energy Balance, 1982 (Ministry of Mines and Energy).

A significant portion of the consumed energy originates abroad. In 1981, 30 % of the total energy use were imported (46,879 x 10^3 toe). A lion share (90%) of the energy imports is attributable to petroleum (42,260 x 10^3 toe).

During 1971- 1981, the total energy consumption in Brazil has grown at a high average rate of 7.1 %/a.

The given energy consumption matrix and dependence on energy inports largely determine the current energy policy, which is focused to become gradually autosufficient (reduction of energy imports) and to achieve a technological autonomy in energy conversion processes. The basic energy strategy towards these targets are:

1. energy conservation

2. substitution of petroleum products

3. increase in national production of petroleum

As to the sectoral energy demand (see the following Table 2), the consumption is concentrated mainly in the industry (37 %) and the transport sector (20 %).

Table 2: Sectoral Energy Consumption (1981)

Sector	10^3 toe	%
Residential	23,907	19.1
Commercial	4,952	4.0
Public	3,390	2.7
Agriculture	6,560	5.3
Transport	24,503	19.6
Industry	45,984	36.8
Others *	15,596	12.5
Total	124,892	100.0

* non-energy sector

Source: National Energy Balance, 1981 (Ministry of Mines and Energy, MME)

Due to the significant share of the industry and transport sector in the overall energy use it is obvious why the government concentrates its energy policy generally, and the energy conservation and substitution policy in particular, on these sectors.

3.2 INDUSTRY

The Brazilian industry is responsible for more than two thirds of the national energy consumption. According to statistic records, the industrial energy consumption increased by a factor of 2.1 between 1967 and 1977, i. e. by 10.5 % annually. In view of a heavy burden on the balance of payment and other adverse implications, the government started a serie of measures towards improving this situation (see Chapter 4). In fact, since 1978 the annual growth of energy consumption has slowed-down to approx. 4 %/a.

The relative importance of the industrial subsectors is shown in the Table 3:

Table 3: Consumption Pattern of the Industry (1981)

Industrial Subsector	10^3 toe	%
Food Industry	1,677	34
Ceramic	1,234	25
Cement	652	13
Pulp + Paper	301	6
Iron and steel	150	3
Chemie	296	6
Textile	148	3
Others	498	10
Total	4,956	100.0

Source: National Energy Balance, 1981 (MME)

As the above table demonstrates, the cement industry belongs among those subsectors with a very significant energy requirements.

3.3 CEMENT INDUSTRY

The cement industry in Brazil has developed rapidly during 1977 - 1980. In 1981, a stagnation in the cement production was registered. The corresponding energy requirements with the respective specific energy consumption are presented in Table 4.

Table 4: Cement Production and Energy Consumption (1976-81)

Year	Cement Production (1,000 t/a)	Energy Consumption (10^3 toe)	Specific Energy Consumption (GJ/t)
1976	19,147	2,876	6.29
1977	21,123	3,111	6.16
1978	23,202	3,351	6.03
1979	24,873	3,348	5.66
1980	27,193	3,411	5.24
1981	26,051	3,271	5.24

Source: National Energy Balance, 1981 (MME)

Whereas the cement production increased by 9.2 %/a during 1976 - 1980, the corresponding energy consumption has grown by 4.4 %/a only. This is reflected by a decreasing specific energy consumption (see Table 4). The main reason for this positive energy behaviour seems to be the changing technological pattern with a growing share of the dry processes in the cement production 1)

Thus, in 1980 about 100 kilns were totally in operation in Brazil. 50 % of the total number of the cement kilns was based on the dry process (about 50 kilns). This portion is expected to further increase for practically all new projects foresee the less energy intensive dry process.

The following table outlines the energy resources and their participation in the energy consumption of the cement industry during recent years:

Table 5: Energy Consumption Pattern of the Cement Industry (in 10^3 toe, %), (1976-1981)

Resource	1976	1977	1978	1979	1980	1981
Fuel Oil	2,223 77.3	2,311 74.3	2,469 73.7	2,317 69.2	1,858 54.5	1,492 45.6
Coal	5 0.2	43 1.4	53 1.6	140 4.2	475 13.9	629 19.2
Natural Gas	- -	46 1.5	46 1.4	46 1.4	48 1.4	23 0.8
Charcoal	-	-	-	-	104 3.0	167 5.1
Electricity	584 20.3	642 20.6	708 21.1	763 22.8	839 24.6	890 27.2
Total *	2,876	3,111	3,351	3,348	3,411	3,271

* rounded

1) In the international context, the modern wet process of cement production requires approximately 1350 - 1400 kcal/kg (5.65-5.87 GJ/t). The energy consumption of the dry process amounts to 800 - 900 kcal/kg (3.35-3.77 GJ/t).

Until 1978, the energy requirements of the cement industry were nearly exclusively satisfied by fuel oil (not mentioning a constant share of electricity). Starting 1979, a gradual introduction of coal marked an area of an intensive substitution process (see Chapter 5).

Remarkable is the use of charcoal in the Minas Gerais which made already for more than 5 % of total energy consumption. The total consumption of fuel oil in the cement industry has decreased from 2,200 x 10^3 toe (77.3 %) in 1976 to 1,500 x 10^3 toe in 1981 (45.6 %), i. e. by 33 %.

4 ENERGY POLICY IN INDUSTRY

4.1 ENERGY SUBSTITUTION

The alarming energy situation in later 70's led to the creation of the National Energy Commission (CNE) (July 4, 1979). The CNE elaborated the so called Energy Mobilization Program with the aim to reduce the dependence on the energy imports by an ambitious energy substitution program.

As a part of this program, special protocols on the energy substitution targets were elaborated for the major industrial consumers of the petroleum derivates: iron and steel, cement, pulp and paper. The protocols stipulated for the cement industry a 100 % substitution for fuel oil till the end of 1984. The principal energy resource for the cement industry should become domestic coal in order to make also an economic use of domestic resources existing in the southern part of Brazil.

In particular, the following phases of reduction of the fuel oil consumption were defined for the cement industry:

Table 6: Energy Substitution Targets for the Cement Industry

Phase	Date*	Reduction in Fuel Oil Consumption (t/a)	Equivalent Coal Supply Requirements (t/a)
1	End of '80	640,000	1,280,000
2	End of '82	2,140,000	4,280,000
3	End of '84	2,780,000**	5,560,000

* date of fulfilment of the target

** a complete substitution of fuel oil is aspired

Source: Information on the program CONSERVE (Ministry of Industry and Commerce), 1982

Compared with the ambicious targets, the effectively reached degree of substitution has slowed-down in the last years:

Table 7: Degree of Fuel Oil Substitution in the Cement Industry

Year	Targets (%)	Effectively Reached (%)
1980	30 %	27 %
1982	80 %	49 % *

* Includes mineral coal, charcoal and other substitutes for fuel oil

However, the following four specific aspects, discussed below, should be taken into consideration before pursuing a complete fulfilment of the 100 % substitution targets:

1. economic limits of the domestic coal
2. technolocical limits of the domestic coal
3. other substitution options
4. national balance of the fuel oil

First, cost of coal production and large transportation distances, together with relatively high investment required at the cement plants level, impose economic constraints on the unlimited use of coal. Currently, the cost of transport are subsided in order to motivate the cement industry towards switching over to coal. Moreover, the existing system of fuel quotes forces the cement producers to use coal as the basic fuel.

The problem of cost of coal is pronounced by large distances between the coal mine area of Santa Carolina and Rio Grande do Sul, and the principal centres of the cement industry reaching from the State of Sao Paulo to the States of Rio de Janeiro, Minas Gerais and Bahia in the North. In addition, a high portion of ash in the Brazilian coal increases cost of the coal transport.

Second, the high portion of ash in the coal (up to 40 %) on the one side, and the varying quality of the raw material for the cement production (limestone) on the other side establish certain technological limits to the use of domestic coal. Ash present in the coal replaces part of the raw material and must be allowed for in chemical and mass balances. Thus, the high portion of ash present in the Brazilian coal must be compatible with the structure of the limestone and clay, particularly with their siliceous fractions. In areas of the coal resources (south), the raw material is less apt to mixing with the excessive percentage of ash in coal. In contrary, more suitable areas to introduce the coal are in the north.

From the above discussed, there is a strong need to test the technological suitability of use of the domestic low quality coal in the Brazilian cement industry under specific conditions on the raw material properties. This knowledge would enable to determine the technologically justifiable and possible use of coal for each region and to set up the optimal fuel mix (coal, fuel oil, others). However, to gain this experience, a <u>pilot cement kiln</u> should be available for the test purposes.

Third, a significant potential of firewood in the central part (Minas Gerais) has made possible a steadily growing use of charcoal in the cement industry. The use of charcoal appears to be economically competitive to coal. The pilot kiln would be also advantageous to test various alternative fuels, such as charcoal, peat, petroleum coke, industrial waste, etc. for their large scale use in the cement industry.

Forth, a due consideration should be given to the national balance of fuel oil. Being a by-product of the petroleum refineries, the quantity of fuel oil largely depends on the refinery pattern, i. e. the production of gasoline and diesel oil. In the industry this, in turn, is given by the existing production pattern of refineries and changing consumption of gasoline and diesel oil in the country. The last factor is a subject to the energy substitution program of the government.

Thus, an annual disponibility of fuel oil according the future expected consumption and production of petroleum derivates should be assessed and its sectoral and regional allocation made. At the moment, it seems to be an excess of fuel oil which is exported at unattractive low prices. Thus, about 1.734×10^6 toe of fuel oil were exported in 1981. For comparison the total fuel consumption of the cement industry in 1981 amounted to 2.371×10^6 toe. The opportunity cost of the fuel oil exports should be measured by cost of production of alternative energy used in the energy.

As a result, differencial instead of uniform regional targets for a fuel oil to coal substitution program would be more appropriate with a corresponding adjustment of existing substitution objectives and targets.

It would be, however, recommendable that the proposed reconsideration of the existing substitution policy in the cement industry at the regional level be closely related to the principal goals of the energy policy elaborated by Regional Energy Plans. To the consultant's knowledge, such energy plans have not yet been prepared for all states.

Consultant's preliminary analysis of the energy substitution options for the cement industry in the state of Minas Gerais is presented in Chapter 5.

4.2 ENERGY CONSERVATION

As an integral part of the Energy Mobilization Program, the so-called program CONSERVE was established by the Ministry of Industry and Commerce in February, 1981. The basic objectives of the program are:

- promotion of a rational use of energy in industry
- promotion of use of alternative energy resources instead of imported petroleum
- stimulation of industrial technological processes with a better energy efficiency
- financing of specific studies, projects and programs towards a basic objection of CONSERVE

In order to implement the energy conservation program in the State of Sao Paulo, a specific agreement was signed in January, 1982, between the National Petroleum Commission (CNP) and the Institute of Technological Research of the State Sao Paulo (IPT).

The principal goals of the IPT's activities consist in:

- technical assistance to the 90 1) largest industrial consumers of fuel oil
- technical assistance and implementation of the energy conservation program within the medium and small industry

1) As the investigation has shown, about 65 % of the national consumption of fuel oil is concentrated in 200 principal industrial companies. 90 of these companies operate in the State of Sao Paulo.

- elaboration of manuals on the sectoral rational use of energy
- organization and performance of the training programs for the operational staff.

Similar programs have been started in other States, such as in Minas Gerais. There, the Institute of Technological Research in Belo Horizonte (SETEC) has become largely involved in the assistance to the medium and small industries.

Parallelly to the technical assistance, the National Petroleum Commission establishes for each industrial subsector administrative energy conservation targets. They form the basis for the fuel supply. In this way, the industry is forced to reduce its energy consumption.

However, the energy quotas are rather related to the global conservation targets and do not necessarily consider specific conditions of each consumer. Thus, those industrial plants which already had reduced their energy consumption are "punished" by this practice because they are supposed to further decrease their energy use. This may of course cause certain production troubles.

With the involvement of the Research Institute in the investigations of the plant level, there is a possibility to determine the energy conservation potential of each consumer based on the detailed diagnosis of the technological processes. In this way, the CNP could relate its stipulated energy supply quotas to a sound estimate of energy engineers. The Consultant recommends to introduce this practice into the cooperation of the CNP with the Institutes.

5 REGIONAL ASPECTS OF THE ENERGY CONSERVATION AND SUBSTITUTION IN THE INDUSTRY

In this chapter, some relevant findings and comments are presented, based on the visits and discussions made with the Technological Research Institutes in Sao Paulo (IPT) and Belo Horizonte (CETEC).

5.1 STATE OF SAO PAULO

The working group of the technological department of the IPT became involved in the industrial energy conservation problems in 1978/79. A series of practical manuals have been elaborated for the following subsectors: cement, textile, ceramics, chemical and food industry.

In the manuals, the areas of energy flows, energy balances, identification of weak points, etc. are generally treated in an adequate, even if in some cases in a too academic, way. However, more emphasis should be given to the economic factors. Thus, evaluation of economic feasibility of proposed technical measures should become an integral part of manuals on the energy conservation.

The first diagnostics have been performed for several selected industrial plants and the energy balances elaborated, based on existing information (i. e. without any measurements).

IPT has organized energy seminar with the aim to develop and dissimilate a uniform methodological approach on the energy conservation problems.

In line with the nationwide energy conservation and substitution program, performance of a detailed diagnosis of 90 significant energy consumers in the State of Sao Paulo is foreseen to start in summer 1983. A continued energy conservation effort will then be focused on hundreds of medium-scale energy consumers (with an annual consumption higher than 500 t/a of fuel oil).

The program foresees detailed investigations comprising elaboration of exact energy balances and diagnostic of present energy situation of each plant and setting up the energy savings targets. The use of two existing and mobile energy units, developed by the IPT, is part of the methodological procedure of the program.

These two energy buses are in their number not adequate for the given task. It is thus recommendable to allocate one of two vehicles planned at the country's level for 1984 (and partly financed by the UNIDO) in the State of Sao Paulo.

Nevertheless, a further need of at least one or two additional "mobile energy measuring units" is obvious, if the comparison of energy consumption in Sao Paulo and the total country is made (1980-figures):

	Total Energy Consumption (1980)		Industry (1980)	
	10^3 tep	%	10^3 tep	%
Sao Paulo	30,800	28.3	14,915	30.1
Brazil	117,970	100.0	49,605	100.0

The State of Sao Paulo is responsible for nearly 30 % of the total energy consumption of Brazil. The share of industry in the State's energy use amounts to 48.4 %. Thus, 14 % of the total energy requirements of Brazil are concentrated in the industrial sector of the State of Sao Paulo.

With the objective to introduce additional energy buses for the program CONSERVE at the national level, an additional Technical Assistance is strongly needed. The conceptional outline of the Technical Assistance is presented in Appendix 2.

In the cement industry, the energy conservation has been primarily related to technological transformation of the wet processes into the dry or semi-dry basis. Economic considerations (high investment, short economic life of existing plants) impose, however, constraints to this procedure.

Parallely, the policy of administrative energy demand targets (fixed by CNP) has been introduced. As mentioned in chapter 4, a coordination is needed between the CNP, IPT and respective industry at the sectorial and plant levels in order to relate energy demand targets to actual energy saving potentials.

In the framework of the program CONSERVE, already 1.2 x 10^6 US$ have been spent in the cement industry for a rational use of energy.

As to the energy substitution, the process of diversification of primary energy resources is in progress. The main attention is given to the coal, although an industrial use of natural gas (Argentina, Bolivia) or synthetic gas on the basis of domestic coal are also being discussed.

In view of the importance which the substitution of fuel oil has for the country's energy balance, the technical feasibility of introduction of domestic low value coal should be demonstrated for different characteristics of the limestone (see also chapter 4). Thus, the IPT has developed the idea of the pilot cement kiln, to serve the testing purposes of technological and energy aspects of the coal consumption and even introduction of alternative energy resources.

The conceptual outline of the project and an eventual technical assistance of the UNIDO is presented in Appendix 3.

5.2 STATE OF MINAS GERAIS

The present energy conservation effort is concentrated in the Institute of the Technological Research (CETEC) in Belo Horizonte. The main subject of technical investigations are medium and small industries. Excluded from the energy conservation program of the CETEC is the cement industry that carries out its own subsectoral studies.

In the past, the activity of the capable energy group has been concentrated to gathering technological experience in such industrial sectors as industry of lime, food, textile and ceramics. Practical manuals have been elaborated for some of the industries.

Several diagnostic studies have been elaborated (for instance for the lime, textile and food industry) and computerized modules of some energy processes developed. The modules enable the setting up of a mathematical model of a given energy process within the investigated plant (i. e. steam production) and simulate the energy balances. This approach is very suitable for the concept of energy buses. The measured process data can be directly processed by small portable calculators installed in the mobile energy unit.

At specific conditions of Minas Gerais, particular attention will be given to the energy substitution options. During his Mission with the CETEC, the Consultant analyzed principal substitution issues for the cement industry. The principal conclusions are summarized in Appendix 4.

PROGRAM OF THE FIELD MISSION

Date	Program	Contacted Persons Messrs.
21.06.1983	- Arrival at Brasilia (at 1 p.m.) - Briefing in the UNIDO/UNDP office, Brazilia	Detlev Broszehl Alfredo Jefferson
	- Meeting with STI (adjustment of the program of the mission)	Jose Fabiam
22.06.1983	- Meeting with the UNIDO - Flight to Sao Paulo (arrival at 2.30 p.m.)	Luis Soto Krebs
	- Meeting with IPT (discussion on energy conservation in the industry)	Fausto Furnari
23.06.1983	- Meeting with the Energy Group Technical University of Sao Paulo (AET), (study on energy conservation in the cement industry)	Fausto Furnari
	- Lunch with the Chief of operational and statistical unit, IPT	Fabio Mariotto
	- Meeting with energy planning group, IPT	Abraham Yu, S. Segawa
	- Meeting with energy conservation group, IPT (diagnosis in the cement industry)	
24.06.1983	- Meeting with Energy Conservation Group, IPT (development of energy conservation programs)	Fausto Furnari
	- Meeting with the Technical Director, IPT	Dr. Paulo Cesar Leone
	- Lunch with representative Secretary for Planning of State of Sao Paulo	Marcio Almeida
	- Meeting with the Energy Planning Units	Walter Ioshida
	Energy Corporation of Sao Paulo CESP	Nilo Doi
25.06.1983	- Flight to Belo Horizonte	

26.06.1983	- Study of existing reports	
27.06.1983	- Meeting with the CETEC (Introduction)	Pompilio Furtado
	- Meeting with the Energy Conservation Group (ECP) CETEC	Angela Menin
28.06.1983	- Discussion on Energy Conservation Programs (lime industry)	Rosemary Bichara M. Novy, UNIDO expert for ceramic industry
	- Study of existing reports	
29.06.1983	- Analysis of the Energy substitution options in Minas Gerais, CETEC	Pompilio Furtado
	- Discussion of Energy Planning Aspects, CET..	
30.06.1983	- Visits of 3 limestone factories	
01.07.1983	- Final discussions, CETEC	Pompilio Furtado Angela Menin

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IPT:	Technological Research Institute of Sao Paulo (Sao Paulo)
STI:	Secretary of the Industrial Technology (Brasilia)
CESP:	Energy Corporation of Sao Paulo (Sao Paulo)
CETEC:	Technological Research Institute in Belo Horizonte

PRELIMINARY PROPOSAL FOR THE TECHNICAL ASSISTANCE "ENERGY MOBILE UNITS" (ENERGY BUSES)

Objective of the Project:

In order to further promote efficient and meaningful performance of the industrial energy conservation program "CONSERVE", the need for introduction of additional energy buses was defined.

Whereas the past activities in this field have been focused on overall diagnostic, the detailed energy measurements are required to determine concrete measures for a rational use of energy, and to set-up targets for an obtainable energy savings.

Subject of the Technical Assistance:

Introduction of 2 - 3 new energy buses at the beginning of 1985 is foreseen. The proposed technical assistance of the UNIDO will be related to financing (or co-financing) of the foreign components of the mobile units, and providing technical support during the initial period of the operation.

Financial Requirements:

1) Financial Assistance
Based on estimates made for the 3 mobile units scheduled for end of 1984, the foreign component for measuring instruments and devices amounts to about US$ 35,000 [1]) per one unit. The tentative list of requested instruments and possible countries of the origin are outlined in Exhibit 1 of this Appendix.

2) Technical Support

	US$
2.1 Project Personnel: 3 MM (3 units)	30,000.-
2.2 Training Program:	20,000.-
2.3 Miscellaneous:	5,000.-
Total (3 units)	55,000.-

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1) Including provision for a price increase between 1983 and 1984

Exhibit 1
of the Appendix 2

SPECIFICATION OF INSTRUMENTS PROPOSED

FOR ENERGY MOBILE UNITS

País de Origem: USA

Fabricante: FLUKE

Item	Quantidade	Descrição	US$	
			Unitário	Total
1.1.1	2	2190 A - DIGITAL THERMOMETEP THERMOCOUPLES - J.K,E,R,S - OPTION 21X0A - 002 ANALOG OUTPUT - DIGITAL OUTPUT 120V. 60Hz. 12 vdc	1.640	3.280
1.1.2	2	Y2030	97	194
1.1.3	2	2300A - SCANNER - WITH THERMOCOUPLE SCANNER CARD. OPTION 2300A - 002 INTERFACE OPTION 2300A - 005 REMOTE CONTROL - 120V. 60Hz	1.550	3.100
1.1.4	2	2030A COMPUTING PRINTER 120V. 60Hz	1.567	3.134
1.1.5	2	36 PIN PTI CABLE, 2ft.	50	100
		Total a transportar		
			Total Geral	9.808

País de Origem: USA

Fabricante: HEWLETT - PACKARD

Item	Quantidade	Descrição	US$	
			Unitário	Total
1.2.1	1	HP 44429-A - DUAL OUTPUT 0 TO ± 10V. D/A CONVERTER	1.200	1.200
1.2.2	3	HP 10833-A - HP-IB. CABLE (1m)	95	285
1.2.3	1	HP 82901-M - FLEXIBLE DISC DRIVE - HP.IB	3.080	3.080
1.2.4	1	HP 82905-B - PRINTER 120V, 60Hz OPTION--002 - HP.IB	955	955
1.2.5	1	HP 7470-A - PLOTTER-120V. 60Hz HP-IB.	1.860	1.860
1.2.6	1	HP 82903-A - 16K MEMORY MODULE	235	235
1.2.7	1	HP 00085-15001 - MASS STORAGE ROM	175	175
1.2.8	1	HP 00085-12002 - PLOTTER/PRINTER ROM	175	175
1.2.9	1	HP 00085-15003 - I/O ROM	355	355
1.2.10	1	HP 82937-A - HP-IB INTERFACE	475	475
1.2.11	1	HP 3311A - FUNCTION GENERATOR	455	455
		Total a transportar		
			Total Geral	9.250

Pais de Origem: USA

Fabricante: POLYSONICS

Item	Quantidade	Descrição	US$	
			Unitário	Total
1.3.1	3	Doppler Ultrasonic flowmeter Model Portable UFM-PD	4.000	12.000
		Total a transportar		
			Total Geral	12.000

Pais de Origem: USA

Fabricante: ALNOR

Item	Quantidade	Descrição	US$ Unitário	US$ Total
1.4.1	2	ALNOR THERMO-ANEMOMETER MODEL-8500-SCALE M/S.	553	1.106
1.4.2	2	PROBE-12 in., 1/4 in DIAMETER	352	704
		Total a transportar		
			Total Geral	1.810

2 - EQUIPAMENTOS FABRICADOS NO JAPÃO

Fabricantes

2.1 Yokogawa Eletric Works, Ltd.
9-32, Nakacho 2 - Chome, Musashimo-shi, Tokyo 180
Phone: 0422.54.111
Telex: 02822.327
Sales office
P.O.Box - 4125 Shinjuku Center Bldg (50F)
1.25.1 Nishi Shinjuku, Shinjuku-ku, Tokyo
Phone: 03.349.0611
Telex: J27584 Yewtok

País de Origem:	JAPÃO

Fabricante:	YOKOGAWA

Item	Quantidade	Descrição	US$	
			Unitário	Total
2.1.1	1	3088-HYBRID RECORDER BASIC CODE - 308823 - DCV, TC&RTD. OPTION CODE - GP-IB	5.500	5.500
2.1.2	4	B 9538JZ - SIX-COLOR RIBBON		
2.1.3	4	B9535 RN-01 - Z FOLD CHART		
2.1.4	2	3088 HYBRID RECORDER BASIC CODE - 308821 DCV&TC	4.040	8.080
2.1.5	1	POCKET CONDUCTIVIT METER	460	460
		Total a transportar		
			Total Geral	14.040

3 - EQUIPAMENTOS FABRICADOS EM UNITED KINGDOM

Fabricante

3.1 <u>Land</u> Combustion Ltd.
Carrwood Road,
Chesterfield Trading Estate,
Sheepbridge
Chesterfield S41 9QB
Phone: 0246.453581
Telex: 547360

Pais de Origem:	U.K.

Fabricante:	LAND.

Item	Quantidade	Descrição	US$	
			Unitário	Total
3.1.1	3	ACID DEWPOINT METER MODEL 200 (preço estimado)	3.500	10.500
		Total a transportar		
			Total Geral	10.500

4 - EQUIPAMENTOS FABRICADOS NA ALEMANHA

Fabricantes

4.1 Leybold - Heraeus GMBH
Wilhelm - Rohn - Strabe 25
POB - 1555 D.6450 - Hanau - 1
Phone: 06181/3641
Telex: 4.184741 Ihhd

4.2 Union Apparatebau
Zeppelinstrasse 42
7500 Karlsruche 21
Phone: 0721/551646
Telex: 07825340

4.3 Zimmermann Inh. Thiel
Laborbedarf - Glasblaserei
5 Koln 41
Ind.Stelzmann STC 52
Phone: 444041

País de Origem: ALEMANHA

Fabricante: LEYBOLD-HERAEUS

Item	Quantidade	Descrição	US$	
			Unitário	Total
4.1.1	2	DOUBLE ANALYSER (TYPE BINOS) OF CO_2 (0-30%) AND CO (0-5000 ppm) DIGITAL, 120V, 60V, 60Hz, OUTPUT 0-1V; 0,06KVA WITH FILTER, CONDENSER, PUMP (0-2,5ℓ/min) METER AND REGULATOR OF FLOW.	9.381	18.762
4.1.2	8	PACKET WITH 50 UNITS. FOR FILTER OF DUST (1 MICRON)	220	1.760
		Total a transportar		
			Total Geral	20.552

Pais de Origem: ALEMANHA

Fabricante: ZIMMERMANN INH.THIEL

Item	Quantidade	Descrição	US$	
			Unitário	Total
4.2.1	3	GASANALYSENGERAT GAG. 125	700	2.100
		Total a transportar		
			Total Geral	2.100

País de Origem: Alemanha

Fabricante: UNION APPARATEBAU

Item	Quantidade	Descrição	US$	
			Unitário	Total
4.3.1	3	TRAGBARER UNION - HEIZWERTMESSER NATH PROSPEKT 125 FUR ANSCHLUB 120V; 60Hz	760	2.280
4.3.2	3	MEHRPREIS FUR EINGFBAUTE AUFLADUNG MIT NICKEL-CADMIUM ZELLEN UND LADEGERAT GEEIGNET FUR UNABHANGIGEN NETZBETRIEB	130	390
		Total a transportar		
			Total Geral	2.670

5 - EQUIPAMENTOS FABRICADOS NA SUÉCIA

Fabricante

5.1 Aga Infrared Systems AB
5-18181 Lidingö, Sweden
Phone: 08-7070020
Cables: Agafarres Stockholm
Telex: 11907 Agairs

Pais de Origem: Suécia

Fabricante: AGA

Item	Quantidade	Descrição	US$	
			Unitário	Total
5.1.1	3	AGA thermopoint 80 Manual-Scaning radiometer	1.600	4.800
		Total a transportar		
			Total Geral	4.800

6 - EQUIPAMENTOS FABRICADOS E/OU FORNECIDOS NO BRASIL

6.1 René-Graf
Rua Florêncio de Abreu 343
São Paulo-SP
fone.: (PABX) 228.83.22
Telex: (11)21668

6.2 Taylor Instrumentos Ltda.
Av. Cursino 1425/1429 - São Paulo
fone.: 275.08.73
Telex: (11)23001

6.3 J.Low Beer S.A Indústria e Comércio
Rua 13 de maio, 204 - São Paulo
fone.: 257.61.99

6.4 Instrumentos Científicos Ética S.A.
fone.: 273.62.24
São Paulo

Pais de Origem: BRASIL

Fornecedor: RENÉ GRAF

Item	Quantidade	Descrição	Cr$	
			Unitário	Total
6.1.1	2	Termômetro digital marca GULTON Modelo Tastotherm D-1200, com faixa de medição de -50 a + 1200°C	747.780	1.495.560
6.1.2	2	Ponta de prova BT-1202(tipo imersão)	235.950	471.900
6.1.3	2	Ponta de prova T-1202(Temperatura Superficial)	174.020	348.040
6.1.4	2	Multímetro digital marca FLUKE modelo 8024	376.500	753.000
6.1.5	2	Tacometro digital marca TAKO modelo TD-301	106.000	212.000
6.1.6	2	Wattímetro de alicate marca YOKOGAWA modelo 243301	600.000	1.200.000
		Total a transportar		
			Total Geral	4.480.500

Pais de Origem: BRASIL

Fabricante: TAYLOR

Item	Quantidade	Descrição	Cr$	
			Unitário	Total
6.2.1	2	TAYLOR Mod. 570AA11010 Analisador digital de oxigênio Tipo: portátil Alimentação: 9Vcc com baterias recarregáveis em níquel cádmio. Carregador para 117V/60Hz. Equipado com bomba interna para sucção da amostra (0,15ℓ(min.)) Escala: 0-100% Célula: Standard Saida elétrica· 0-1 Vcc Especificação: File 18-22	3.700.000	3.700.000
		Total a transportar		
			Total Geral	3.700.000

País de Origem: BRASIL

Fabricante: J.LOW BEER

Item	Quantidade	Descrição	Unitário	Total
6.3.1	2	Duplex Fyrite Kits - CO_2 - O_2, código 10-5020	464.000	928.000
6.3.2	4	Frasco de fluido para O_2, código 105060	46.000	184.000
6.3.3	2	Válvula de entrada verde, código 110127	10.000	20.000
6.3.4	2	Válvula de saída vermelha, código 110138	10.000	20.000
		Total a transportar		
			Total Geral	1.152.000

País de Origem: BRASIL

Fabricante: INSTRUMENTO CIENTÍFICO

Item	Quantidade	Descrição	CR$ Unitário	CR$ Total
6.4.1	1	Estufa modelo 420/7E com circulação de ar forçado, dimensões internas (1,00 x 0,90 x 0,70) 220V trifásico	505.500	505.500
6.4.2	5	Prateleira para estufas	3.000	15.000
		Total a transportar		
			Total Geral	520.500

Pais de Origem: Japão/Brasil

Fabricante: IWATSU

Item	Quantidade	Descrição	US$	
			Unitário	Total
6.5.1	1	Oscilloscope IWATSU Model SS6050 TZ Obs. Este osciloscópio pode ser comprado no mercado nacional. O preço constante em Cr$ é aproximado.	3.850 Cr$3.850.000,00	3.850
		Total a transportar		
			Total Geral	3.850

Cr$ 3.850.000,00

FORNECEDOR	TOTAL Cr$
6.1	4.480.500,00
6.2	3.700.000,00
6.3	1.152.000,00
6.4	520.500,00
6.5	3.850.000,00
TOTAL GERAL	13.703.000,00

IPT	4.594.500,00
CETEC	4.554.250,00
FTI	4.554.250,00

FABRICANTE	TOTAL (US$)
1.1	9.808
1.2	9.250
1.3	12.000
1.4	1.810
2.1	14.040
3.1	10.500
4.1	20.552
4.2	2.100
4.3	2.670
5.1	4.800
TOTAL GERAL	87.530

IPT	25.900
CETEC	30.815
FTI	30.815

PRELIMINARY PROPOSAL FOR THE TECHNICAL ASSISTANCE "PILOT CEMENT KILN"

Objective of the Project:

In line with the basic objections of the Brazilian energy policy, the substitution of fuel oil presently used in the industry by domestic coal is promoted. In the cement industry, the low quality coal with a high ash content may cause serious technological problems or limits of mixed with limestone of a low content of siliceous parts. The energy substitution process also requires consideration of regionally available energy resources, such as charcoal, peat, industrial waste or gas. Experience with that type of fuel should be made first before their introduction into commercial process.

Thus, installation of an adequate testing cement kiln is proposed as "final target". The project consists of 3 phases:

Phase I:

Study of technical justification of the project (duration approx. 3 months).
Purpose: Technical justification, conceptual design, cost estimate, institutional aspects of construction and operation.

Phase II:

Detailed conceptual design.

Phase III:

Construction and commissioning.

Tentative Time Schedule:

Phase	To Finish Till:
I	End of 1st quarter 1984
II	End of 1984
III	End of 1985

Subject of the Technical Assistance:

In the short-term, the Technical Assistance will be focused to support the local counterpart in elaboration of the study (Phase I). Depending on the results, further financial and personnel support will be needed.

Financial Requirements:	1.	Technical Support	US$
	1.1	Project Personnel: 1 MM (Phase I)	10,000.-
		4 MM (Phase II)	40,000.-
	2.	Financial Support	

Depends on the evaluation of the instrument cost and the investigated financing mode of the project.

Appendix 4

SOME PRELIMINARY CONSIDERATIONS ON THE ENERGY SUBSTITUTION PROCESS IN THE CEMENT INDUSTRY OF THE STATE OF MINAS GERAIS

CONTENTS:

I. TECHNOLOGICAL MATRIX OF ENERGY SUBSTITUTION OPTIONS

Alternative Energy	Energy Basis	Alternative Technological Process	Preparation Phase	Transport	Transformation	Implementation in the Cement Industry	Remarks
A) Primary							
Wood	Forests (natural, artificial)	Direct use (combustion)	Homogenizat.,Drying	Road	-	Tests,Large Areas of Stock	evt. Fuel Mix Capacity?
		Gasification	Homogenizat.,Drying	Road, Pipe	Gas	Tests,Temperat.,Stability	evt. Fuel Mix Capacity?
		Carbonization (see Charcoal)	Homogenization	Road	Briquets,pulver	Tests	Problem of Scale
Peat	Peat Mines	Direct use (combustion) Gasification	Mining, Drying	Road	Pulver,Briquets Gas	Tests (Stability)	Combustion Tests
Biomass	Agriculture	Digesters Direct use (combustion) Gasification Casbonization	Collection	Road	Gas Gas Briquets	Tests:Temperat.,Stability " " " " " " " " "	Combustion Tests Problem of Scale
Natural Gas	Imports	Direct use	-	Pilelines	-	Easy	Well-known application
B) Secondary							
Charcoal	Wood Biomass Peat	Direct use Gasification	Carbonization Briqueting (Pulverization)	Road	Gas	Tests (Temperature, Scaling)	Tests of Combustion (Temperature)
Petroleum Cogne	Petroleum (residual)	Direct use	Pulverization	Road	Pulver	Tests	Coordinate with Petroleum Balance
Industrial Waste	Mixture	Direct use Gasification	Collection, Homogenization	Road	Briquets Gas	Mix with othr energy	Stability of Combustion
Rubber		Gasification	Cutting	Road	Gas	Mix with other energy	Stability of Combustion

II. EVALUATION OF THE TECHNOLOGICAL MATRIX

Technological Process	Related Energy	Commercial Application	Required Development	Adjustment to Cement	Cost of Energy Supply	Environmental Aspects	Other Aspects	Overall Evaluation
Direct Combustion	Wood	Less Suitable for Cement		Problem of Scale	Low	Balance Forestal	Cost/Price Stability	-
	Charcoal	Possible		Necessary	Low	Balance Forestal	Cost/Price Stability	Positive
	Peat	Possible	Practical		To Be Investigated	Mining, Transport	Drying	Positive
	Biomass	Less Suitable (Scale)	Testing at Larger	Problem of Scale	Low	None	Scale	Less Suitable and as Mix only
	Petroleum Coke	Possible	Scale		To Be Assessed	Not Special	Related to Refinery Balance	Possible
	Industrial Waste	Possible		Scale	Low	Positive	System of Collection and	Possible
	Natural Gas	Possible		Scale	To Be Defined	None	Homogenization	As Mix only Highest Priority
Gasification	Wood	Less Suitable	Mixture	Scale	Low	Balance Forestal	Cost/Price Stability	(Possible - Mixture)
	Charcoal	Possible	Practical Testing at Larger Scale	Scale	Low	Balance Forestal	Cost/Price Stability	Possible
	Biomass	Possible	Mixture (Temperature)	Scale	Low	None		less suitable
	Industrial Waste	Possible	Mixture	Scale	Low	Not Special	Collection, Homogenization	Possible as mixture
	Rubber	Less Suitable (Stability)	Mix		Low			Less Suitable
	Peat	Possible	Gasification Tests		To Be Investigated	Mining, Transport	Drying	Possible
	Petroleum Coke	Possible	Gasification Tests		To Be Investigated	Mining, Transport Not Special	Drying	Possible

III. ENERGY REQUIREMENTS OF THE CEMENT KILN

1. Technical Characteristics

Installed Capacity: 350 t/d

Annual Utilization: 330 t/a = 7,920 h/a

Dry Process

Specific Energy Consumption: 900 kcal/kg

Hourly Indicators:

Production: 14.5 t/h

Energy Requirement: 14.5×10^3 kg . 900 kcal/kg =

13,050 Gcal/h

2. Calorific Value of Alternative Fuels (Approx.)

Fuel Oil	=	10.0 Gcal/t
Coal	=	5.0 Gcal/t
Charcoal	=	6.5 Gcal/t
Peat	=	3.0 Gcal/t
Biomasse	=	2.6 Gcal/t
Wood	=	3.0 Gcal/t
Rubber	=	9.0 Gcal/t
Industrial Waste	=	2.5 Gcal/t

3. Average Efficiency of Transformation Process:

Direct combustion : included in energy requirement of the kiln

Gasifiers: 80 %

4. Fuel Consumption of Alternative Energy Resources Process

4.1 Direct Use

	Consumptions	
	Hourly (t/h)	Annual (t/a)
Fuel Oil	1.3	10,375
Coal	2.6	20,600
Peat	4.4	34,450
Wood	4.4	34,450
Ind. Waste	5.2	41,350
Biomasse	5.0	39,600
Charcoal	2.0	15,900

4.2 Gasification

	t/h	t/a
Charcoal	2.5	20,000
Wood	5.5	44,000
Biomasse	6.3	50,000
Ind. Waste	6.5	52,000
Rubber	1.8	14,500

IV. ENERGY AND TECHNOLOGICAL PRIORITIES FOR ALTERNATIVE ENERGY RESOURCES IN CEMENT INDUSTRY

(Tentatively)

Energy Basis	Priorities: Gasification	Priorities: Direct Combustion
A) Primary Energy		
Natural Gas	–	1
Wood	2	3
Peat	2	1
Biomass	3	3
B) Secondary Energy		
Charcoal	1	2
Petroleum Coke	2	1
Industrial Waste	2	2
Rubber	4	4

1..... highest priority
2..... suitable
3..... less suitable
4..... important problems (scale, technology, etc.)

V. CONCLUSIONS

1. Availability of large scale and flexible (robust) gasifiers is essential for introduction of alternative energy forms into the cement industry.

2. Existency of a pilot cement kiln appears to be pertinent in order to perform respective energy/combustion tests.

VI. RECOMMENDATIONS

3. Based on the preliminary energy/technology matrix, it appears that the highest attention and priority for their use in the cement industry should be given to:

   - gasification processes of various energy focus, expecially of charcoal and wood

   - direct combustion of natural gas, peat and eventually petroleum cogne.

4. Investigation of a sufficient energy basis in terms of high and continuous energy requirements (5 - 10 years period) should be performed.

5. Technological suitability of alternative energy options with special regard to the large scale, reliable and continuously intensive energy use in the cement industry should be carefully investigated.

6. For each investigated energy alternative the cost of energy supply should be estimated taking into account all components: energy production, transport, transformation, end-use. Cost indicators are to be related to the use of coal.

7. Financial requirements of introduction of new alternative energies into the cement industry should be estimated.

8. Assessment of side-effects of particular energy resources in terms of their benefits and costs should be made.

9. List of recommendations for introduction of a new energy should be related towards a detailed plan of action, comprising such aspects as:

   - technological development, adjustments and tests
   - economical measures (energy pricing, subsidies)
   - institutional and organizational implications
   - environmental implications (deforestation)