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ENERGY SITUATIONS IN ETHIOPIA*

Prepared by

Mr. B. Kiflay**

Mr. S. Bantileku***

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** Ministry of Industry, Ethiopia

*** Ethiopian Pulp and Paper Corporation, Ethiopia

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1. INTRODUCTION

1.1 GENERAL BACKGROUND:-

Ethiopia's population of about 45 million in 1986 is largely rural deriving its livelihood from predominantly agricultural activities.

The energy resource of the country, as preliminary studies and surveys conducted so far indicate that hydro and geothermal energy resources are immense while solar, biogas and biomass resources are quite sizable. For instance, the whole territory of Ethiopia has gross hydro potential of the order of 650 Twh/year (Twh = 10^9 kwh). Exploration activities and geological investigations carried out to date shows that significant natural gas resources have been found in the Ogaden to the extent of at least 10 to 30 billion m^3 , giving rise to considerable expectations of oil and gas potential and spurring exploration activity in the area. Apart from these energy resources others such as lignite reserves, uranium, and similar energy resources have been detected.

Despite the country's energy potential, the energy sector has remained at a low level of development. This is a reflection of the low level of industrialization of the economy. Further more, energy resources like petroleum, and geothermal require a lot of investment and technological know-how from the preliminary stage through exploitation. Consequently, the traditional energy resources i.e. fire wood, animal and plant wastes, and farm residues constitute the major sources of Ethiopia's energy supply.

In 1984, the total final domestic energy consumption amounted to 139.5 thousand Tcal, of which only 6.6 thousand Tcal, or less than 5% of the total final consumption was contributed by modern fuels i.e oil product and electricity (5.9 thousand Tcal oil product + 0.6 thousand Tcal electricity).

The industrial sector consumption was 8.5 thousand Tcal, or 6.1% which came second to the household sector whose consumption was 114.4 thousand Tcal or 82% of the final energy consumption. The energy demand of the country is expected to increase from 126 (exclusive of human labour and animal power inputs) to 225 thousand Tcal between 1984 and 2005 and the fastest growing sector in terms of final energy requirement is modern industry with growth rate of 7.4% per year.

1.2 ENERGY PLANNING

In order to meet the energy requirements of the country plans and strategies were formulated for the energy sector in the drafts of the 10 year perspective plan (1984/85-1993/94). Some of the main objectives are:

- to ensure the supply of commercial energy to the economic and social sector;
- to reduce the dependence on imported petroleum by both conservation measures and development of alternative energy sources - hydro electrical, geothermal, biomass and solar;
- to adopt conservation and efficiency measures for traditional energy sources. For this special attention will be given to introduction of improved and efficient stoves, and modern kilns for the preparation of charcoal from cut wood.

The strategies were formulated with little available information and poor level of quantitative knowledge of Ethiopia's energy resources, supply and consumption. Therefore they were not adequate; however, it shows that considerations and efforts have been done with regard to energy planning.

In order to improve the country's energy planning, study has been conducted by ENEC (Ethiopia National Energy Committee) with technical assistance from CESEN (Italy).

The scope of the study, which was developed within thirteen broad working groups, stretches across the whole energy field; from resources and supply systems to final consumption, from energy technology assessment and energy savings to energy demand forecastings and finally, to the interrelations between energy development and the rest of the economy. Report preparation of the studies were completed in November 1986 and one week workshop was organized in January 1988.

Based on the study, a draft of energy policy is prepared by ENEC. At present the draft policy is distributed to concerned organizations for comments, and in the near future the energy policy of Ethiopia will be finalized.

1.3 PRICING OF FUELS AND ELECTRICITY

Furnace oil and electric energy are the principal energy sources used in the industry. All public electricity supplies in Ethiopia are provided by the Ethiopian Electric Light and Power Authority (EELPA), which operates three systems:

- i. The main interconnected system (main ICS), which accounts for two-thirds of the country's total installed capacity (total-298MW as at 7 July 1987) and which is almost entirely hydro-power based;
- ii. The main self-contained system (main SCS), which accounts for 12 per cent of total installed capacity and which is supplied by a large number of isolated diesel stations;
- iii. The ERESA system covering the Eritrea region, the accounts of which are treated separately within EELPA. This system is subdivided into the ERESA ICS, supplied from interconnected thermal power stations (with one-fifth of total installed capacity), and the ERESA SCS, supplied from isolated diesel stations (with one percent of total installed capacity).

For pricing electricity there are three distinct tariff zones: The main ICS, the ERESA ICS, and the self-contained systems (the main SCS and the ERESA SCS are grouped together for tariff purposes).

The summary of the present tariff, which came into effect in March 1986, is as follow:-

Main ICS:	Industrial HV	20.29	E¢/Kwh
	Industrial LV	22.32	"
ERESA ICS	Industrial HV	32.06	"
	Industrial LV	34.90	"
SCS	Industrial HV	-	
	Industrial LV	43.97	

(E¢. Ethiopian Cents)

The tariff is flat rate energy charge. There is no maximum demand charge and no time-of-day (peak/off-peak) energy rates. The maximum demand readings of industrial consumers are taken only to establish penalty on power factory. Power factor charges are at 1 percent of the (national) MD charge for each 0.01 by which the power factor falls below 0.85.

The present tariff represents an average 78 percent increment over the previous tariff levels (which had been in force since 1978).

The prices of petroleum products in Ethiopia are administered by the government, with the original objective of covering the financial costs incurred by the Ethiopian Petroleum Corporation (EPC). The EPC operates a 20 year old, 800,000 tonne/year refinery at Aseb which imports all crude oil. The product yield of the refinery is not enough for local market requirement, and as a consequence additional refined product are imported. However, there is surplus of heavy fuel oil that must be exported.

The retail price of furnace oil (H.H.V042.5 MJ/kg), is 54.0 EC/litre in Addis Ababa. (Transport charges from Aseb to Addis Ababa are around Birr 200/tonnes and from Asab to Asmara Birr 360/tonne. Transport costs for other remote locations are EC/22.9/m³/km, added to the Addis Ababa retail prices.)

2. Industrial Sector

2.1 Background

The industrial sector in Ethiopia is comprised of state-owned industrial enterprises under different ministries, and privately owned

small scale industries. Presently, there are around 197 state owned industrial manufacturing enterprises of which 162 (or 82 percent) are under the Ministry of Industry (MOI). Out of these 162 manufacturing enterprises 4 of them are share companies, (i.e. have foreign share holders). These establishments (under MOI) are contained within 10 corporations, which are organized on the basis of similarities in production processes and product types.

The Ministry of Industry was established in September 1976 to:

- direct, supervise and plan the development of industrial enterprises transferred to the public sector;
- rehabilitate, expand and organize public enterprises;
- formulate industrial policies and strategies for industrialization of the country;
- select appropriate industrial technologies to be implemented in the country;
- handle both bi- and multi-lateral industrial relations with the developing and developed countries in accordance with the foreign policies of the government.

2.2 Industrial Development Policies

According to the Ten year Perspective Plan, the manufacturing sector is the second top priority, after agriculture. Government policy for the industrial sector is to expand industries based on local resources in order to enhance the inter-sectoral linkages particularly among agriculture, mining and industry. The industrial Gross Domestic Product is planned to grow at an average annual rate of 8 percent during the plan period. The share of industry in the

GDP is expected to rise from 16 percent in 1983/84 to 23.9 percent in 1993/94.

2.3 Energy Consumption

In 1985/86 all manufacturing establishments under the control of the MOI spent nearly Birr 91 million (US \$43.96 million) on the purchase of energy in the form of furnace oil, diesel oil, petrol and electricity. Of this amount purchase of furnace oil accounted for Birr 38 million (US \$18.36 million) and electricity Birr 35 million (US\$16.91 million) a total of Birr 73 million ^(US\$ 35.29 million). The cost of Energy as a percentage of gross value of production for each corporation is tabulated as follows.

Energy Cost as Percentage of Gross Value of Production (1985/86)

No.	Corporations	Energy Cost %
1	Ethiopian Food	2.69
2	Ethiopian Beverage	2.13
3	National Tobacco & Match	1.58
4	National Textile	6.63
5	National Leather & shoe	1.61
6	Ethiopian Printing	0.78
7	Ethiopian Cement	41.23
8	National Chemical	2.64
9	National Metal Works	1.86
10	Share Companies (4)	5.38

Note: Ethiopia Sugar Corporation is excluded because the sugar Factories use mainly bagasse as energy source.

3. Industrial Energy Conservation Activities

Since 1982, considerable studies have been done on the energy sector of Ethiopia. Energy sector studies like "Issues and Options in the Energy Sector" (World Bank Report 1984), and "Energy Sector Study" (CESEN Reprot 1986) discuss conservation of industrial energy as one of the end users options. But the recommendations were general and suggest further studies to be done on conservation of industrial energy.

Another important study: "Bagasse Energy Survey" (Joint UNDP/World Bank Energy Sector Management Assistance Programme Report, Dec. 1986), aims at:

- assessing the possibility of producing excess bagasse, in which case at present, bagasse as energy source, is completely consumed by the sugar industry, and
- assessing the potential use of bagasse in other economic activities of the country such as production of pulp, particle board feedstock, power generation, and briquette.

The sugar industry consisting of three mills currently process about 1,640,000 tons of cane, producing 186,000 tons of sugar annually. The engineering analysis of "Bagasse Energy Survey" report shows that 102,000 tons (bone dry) of net excess bagasse could be generated on ce investments in certain mill modifications had been made. These consist of improvemnts in factory steam utilization, more efficient boiler operation by pre-drying bagasse, and savings of bagasse from burining particles captured in the drying process.

A simple but useful study on "power factor correction" in the factories of Ethiopian Food Corporation (E.F.C.) has been done by two engineers from EFC in July 1987. For example, the EFC factories which

operate with power factor less than 0.85 have paid sur charge of Birr 52,008 (US\$25,125) in 1985/86. To improve the power factor of these factories, as the report shows, Birr 169,296 (US\$ 81,785) is required to purchase the power capacitors.

Technology Policy and Research Department of MOI, established in 1985, has an aim to establish Industrial Energy Management System. In 1986, Ministry of Industry got an expert assistance for 3 months from UNIDO and made the first coordinated industrial energy utilization study. The purpose of the study: "Optimisation of Energy Control and use by an Integrated Programme (OECUIP)" was to elaborate a detailed and inegrated energy utilization programme for the manufacturing industries of Ethiopia with a view to achieve optimum use.

Based on the study conducted by the UNIDO expert, and recommendations forwarded by joint UNDP/World Bank Energy sector assessment programme, Industrial Energy Efficiency Study Project (IEESP) is undergoing since November 1988 and will last till October 1989.

The financing of the IEESP was secured from the international Development Agency (IDA) through the Ethiopian National Energy Committee of the Ministry of Mines and Energy which has the responsibilities of directing this project in collaboration with Technology Policy & Research Department.

The project is to be carried out in two phases: phase I and Phase II. The main activities of phase I are:-

- brief energy audits or preliminary studies of 30 selected factories;
- selection of 15 factories for detailed energy audits and identification of instruments and tools to be purchased for use during the detailed energy audits to be carried out in phase II;

The main activities of phase II are:-

- detailed energy audits and identification energy efficiency measures in the 15 factories and priority listing of the measures in order of profitability, and
- provision of two week training seminar on energy conservation in theory and practice.

4. Barriers of Energy Savings

The main barriers of energy conservation activities are:-

- absence of well-defined and publicized government policy toward energy management.
- Technical problems, specially lack of measuring, testing, recording to instruments
- financial and economic constraints,
- lack of datas which help to analyse energy utilization,
- lack of trained manpower in industrial energy conservation and management
- lack of awareness in industrial energy management.

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Annex

ETHIOPIAN PULP & PAPER S.C.

1.0 INTRODUCTION

1.1 PAPER MILL

The Ethiopian Pulp & Paper S.C. which is located at Wonji, about 90km South East of Addis Ababa was commissioned in 1970 and is the only producer of Paper and Board in the country. Since its beginning, it has been producing printing, writing, stationery and wrapping paper, and boards with basis weight ranging from 40 to 300 gm/m².

The existing paper machine currently produces approximately 10,000 tons per annum of the above grades on a single BLACK CLAWSON FOURDRINER type paper machine, 284 cm wide. Imported fiber stock is used as the principle raw material.

Most of the equipments were designed for future production of 50 metric tons per day and the 2nd phase of the original plan include the expansion of the paper mill to this capacity. However, this didn't materialized in the early years of its beginning as other unforeseen problems were encountered at that time.

A study of the paper market in Ethiopia indicated that over the seven years prior to 1987 the mill has produced approximately 35 percent of the total domestic consumption of paper and board.

To increase its share of the existing market EPPSC plans to expand its output of the existing paper machine and to install a second paper machine. The 1st phase of modification to the existing machine had been undertaken in 1987 and the 2nd paper machine is scheduled to be in operation in 1992. The maximum capacity of the expanded paper mill would be approximately 48,000 tons per annum.

Dependence on imported pulp will continue until domestic sources can be used. A pulp mill based on bagasse as raw material is scheduled to be installed in 1992.

2.0 ENERGY CONSUMPTION

2.1 STEAM SUPPLY

The steam requirement for the existing paper machine is averaged 6 tons per hour with a peak load of 7 tons per hour. This is being generated by 5 electric boilers having a total design capacity of 21 tons per hour and design pressure of 20 bar. The operating pressure is 10 to 12 bar. The boilers are rated at 3Mw at 660V.

2.2 ELECTRICAL POWER SUPPLY

Electric power to the paper mill is purchased from the Ethiopian Electric light and power authority grid system at a rate of 5 cents per KWH for Electric Boiler and 20.29 cents per kwh for the paper mill supporting equipments.

The total annual power consumption is averaged 46,000 Mwh. of this total, 37,000 MWH is being consumed to generate steam for the paper machine and box making plant. The maximum demand is 13,200 KW.

3.0 EPPSC'S ENERGY CONSERVATION MEASURES

In view of the growing demand of printing and writing papers, EPPSC has given more emphasis to expand its output rather than installing energy conservation equipments. However, during the rebuild of the existing paper machine which was carried out in 1987, some modification were made to reduce water and energy consumption (both electric power and steam). New energy conservation equipments such as heat exchangers were installed and deteriorated insulation materials were changed. In addition to that, older equipments which were requiring high electric power demand were replaced with modern ones.

By installing the proper size of heat exchanger the steam and condensate system was established; and the condensate return to the hot well was increased by 250 percent. Hence the need for makeup water had reduced, thus helping keep the total dissolved solids values below the acceptable limits and reducing the need for boiler treatment chemical. In addition to this, substantial saving of energy was achieved by using recovered condensate having an average temperature of 95.C^o.

4.0 BARRIERS OF ENERGY CONSERVATION

The main barriers of energy conservation at EPPSC are detailed as follows.

1. The unavailability of financial resources for energy conservation investment.
2. Lack of training and inadequate know-how, skill and experience of the management in the field of energy conservation measures.