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GHANA ENERGY SECTOR ASSESSMENT REPORT

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OFFICIAL FISCAL YEAR

January 1 - December 31

CURRENCY EQUIVALENTS

Currency Unit:		Cedi (¢)
US $1 =	305	(January 1990)
	338	(September 1990)

ENERGY CONVERSION FACTORS

	Physical Unit	Calorific Value (kcal million/ physical unit)	Oil Equivalent (toe/physical unit)
Fuelwood	m^3	2.90	0.25
Fuelwood	M.T.	3.50	0.34
Charcoal	M.T.	6.90	0.68
Agricultural Residues	M.T.	2.00	0.20
Crude Oil	M.T.	10.20	1.00
LPG	M.T.	10.85	1.06
Gasoline	M.T.	10.46	1.03
Kerosene	M.T.	10.33	1.01
Jet Fuel	M.T.	10.40	1.02
Gas Oil	M.T.	10.24	1.00
Fuel Oil	M.T.	9.40	0.92
Electricity (Gwh)			
100% Generation Efficiency		860	84.3
34% Generation Efficiency		2,530	248

ABBREVIATIONS

bbl	barrel containing 42 US gallons
bpd	barrel per day
gal	gallon (British - 4.546 liters US - 3.785 liters)
cm^3	cubic centimeter
ft^3	cubic foot
ha	hectare
kgoe	kilogram of oil equivalent
lpg	Liquefied Petroleum Gas
mm	millimeter
m^2	square meter
m^3	cubic meter
M.T.	Metric ton
sec	second
toe	ton of oil equivalent
tpy	metric ton per year
MW	Megawatt
KW	Kilowatt

ACRONYMS

BEICIP	Bureau d'Etudes Industrielles et de Cooperation de l'Institut Francais du Pétrole
CDC	Commonwealth Development Corporation
CEB	Communauté Electrique du Benin (Benin-Togo Binational Electricity Authority)
CIDA	Canadian International Development Agency
CTFT	Centre Technique Forestier Tropical
ECG	Electricity Corporation of Ghana
ECOWAS	Economic Community of West Africa
EECI	Energie Electrique de la Côte d'Ivoire
EIB	European Investment Bank
ESB	Electricity Supply Board of Ireland
ESMAP	Energy Sector Management Assistance Program
GHAIP	Ghana Italian Petroleum Company
GIHOC	Ghana Industrial Holding Company
GOIL	Ghana Oil Company Ltd.
GNPC	Ghana National Petroleum Corporation
GRC	Ghana Railways Corporation
Kfw	Kreditanstalt für Wiederaufbau (Federal Republic of Germany)
MFP	Ministry of Fuel and Power
NEB	National Energy Board
NORRIP	Northern Region Rural Integrated Program
ODA	Overseas Development Administration (United Kingdom)
PCIAC	Petro Canada International Assistance Corporation
PIP	
PNDC	Provisional National Defense Council
UNCTC	United Nations Center on Transnational Corporations
UNDTCD	United Nations Department of Technical Cooperation for Development
UNIDO	United Nations Industrial Development Organization
VALCO	Volta Aluminum Company
VRA	Volta River Authority

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BACKGROUND AND OBJECTIVE OF REPORT

From mid-1970s to early 1980s, Ghana's socio-economic, financial and political situation deteriorated markedly. Wrong policies and adverse external factors coupled with an unrealistic exchange rate worsened the plight of the country.

In 1983, the Government of Ghana (GOG) adopted an Economic Recovery Program (ERP). Since then, the downward trend of the country's situation has been reversed through the support of the International Monetary Fund (IMF), the World Bank and other donors. The GOG's current strategy under the ERP is to revitalize the country's economy, infrastructure and accelerate rural development. The GOG has introduced, since 1988, the Public Investment Program (PIP) in order to improve the productivity and consistency in public investment. This is a "rolling" public investment based upon three-year programming periods and linked to annual preparation of the national budget. There is annual review of the PIP and at that time only projects that meet priorities and economic rate of return criteria, established under the ERP with funding assurance, are included. Among projects that qualify for inclusion in PIP, priority is given to those that support rehabilitation and maintenance of existing assets. The energy sector is one of the priority sectors in the GON's program.

Under the Energy Sector Management Assessment Program, the World Bank/UNDP mission studied Ghana's energy situation with a report released in November 1986. The report identified the following severe constraints on the energy sector: (a) the scarcity of foreign exchange needed for maintenance and rehabilitation; (b) the high cost of petroleum imports; (c) accelerated deforestation, especially in the north-east; (d) institutional weakness at the sectoral level and in the operating entities. The report recommends short-term actions for (1) rehabilitating the infrastructure and productive installations in the electricity and petroleum subsectors (2) improving energy demand management through economic cost pricing and non-pricing measures to increase energy efficiency (3) strengthening energy planning and policy coordination. The report also (for medium term), recommended an investment program based on least-cost options for meeting future energy requirement needs to be implemented which offers scope for increased private sector involvement. The program emphasized institutional strengthening, policy analysis and project preparation.

Based on the World Bank/UNDP report, GOG has come out with a policy framework under the ERP to address the energy constraints. With technical assistance, GON has established strategies and fundable investment projects in the sector.

This report analyzes the current energy situation, outlining progress being made in the various energy subsectors since the World Bank/UNDP Assessment Report in 1986. The report identified existing constraints on increasing output and improving efficiency in the subsectors. The options available and steps required to overcome such constraints are identified with environmental considerations. Information is provided on government strategies, public investment programs and future projects in the energy sector.

The report was prepared under the African Development Support Program (Project No. 698-0464) funding. Data for the report was obtained from the staff of the National Energy Board, Electricity Corporation of Ghana and a number of professional and scientific publications. Contacts with the Council for Industrial and Scientific Research, the Forestry Department and various individuals also provided useful information.

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EXECUTIVE SUMMARY

The Country Background

The republic of Ghana is located in West Africa. Though it has rich natural resources, its economy is heavily dependent on cocoa for foreign exchange. After a period of political upheaval and economic decline, Ghana is now stable and has been following ERP since 1983. The ERP reversed the downward trend in the economy. The second phase which emphasizes rehabilitation of a infrastructure, has been launched.

Energy Sector Institutions

Energy institutions are either utility agencies or research oriented. Ministry of Fuel and Power is responsible for the development and implementation of energy policy. National Energy board is the agency for overall policy formation and coordinating energy matters. The Volta River Authority generates and transmits high voltage hydro power in addition to responsibility for low voltage distribution in northern part of Ghana. ECG is responsible for low voltage distribution in Southern Ghana. ECG's institutional weakness is being addressed by Electricity Board of Ireland. The Ghana National Petroleum Company is responsible for exploration, development and procurement of petroleum. It is spearheading exploration drives to evaluate commercial hydrocarbon resources available in the country. Ghana Italian Oil company undertakes the refining and distribution is by the private sector. The universities, institutes of the council of Scientific and Industrial Research and Department of Forestry undertake research and projects for the energy sector in general and renewable energy in particular.

Energy Resources

Ghana has relied on woodfuel and hydropower to meet its energy requirements. There is a growing demand on woodfuel sources by the growing population. Charcoal is used predominantly by the urban population while firewood use is dominated in the rural areas. Savanna woodland is most vulnerable to depletion pressure from uncontrolled deforestation. Estimated hydroelectrical potential is 2,000 Megavolts from three major river systems. Forty mini hydro potential sites have also been identified. Petroleum, 23 per cent of national energy consumption is obtained from crude oil imports. Deposits of crude and natural gas have been identified. Solar energy is abundant and studies for its exploitation is in progress.

Biomass Energy

Firewood in the rural and charcoal in urban areas constitute the predominant biomass energy consumption in Ghana. Together they constitute over 75% of the country's domestic energy consumptions.

Though supply sources cover the whole country, uncontrolled exploitation in face of increasing population growth is an environmental concern. The constraints on preservation of the forests and Savannas while meeting energy needs have been identified. The government is taking required actions by implementing projects and strengthening institutional capacities that will install sustainable forest resources. Biogas is being introduced on an experimental basis. Its potential in the country has been assessed and efforts are underway to address the constraints to widespread use in the country.

Petroleum Energy

Ghana imports crude oil for refining and distribution for domestic consumption. The large proportion of foreign exchange (26 percent in 1986) taken by crude imports is behind the elaborate effort of the government's exploration drive. Refining and distribution extensions and efficiencies are parts of ERP to minimize national Petroleum consumption. LPG recovery and its increased use in the country is proceeding satisfactorily.

Electrical Energy

Ghana's hydroelectric system has potential to supply 6055 Gwh of electric power in a normal hydrologic year. Diesel-power generation has not been efficient and are being replaced by hook-ups to the grid system where possible. The Ghana grid is interconnected with Cote d'Ivoire, Togo, Benin and there is a provision to eventually connect to Burkina Faso. The bulk of Ghana's electricity supply (65 percent) is taken by VALCO. As hydropower is vulnerable to draught, supplementary power requirement in the future are to be met from thermal generation. Present electricity coverage of the country is low about 5%. The government's policy is to cover the whole country by 2020 and programs underway for accomplishing this.

Energy Research

Through the National Energy Board and the Energy Research Group, energy research problems are being addressed and research activities are addressing priority energy issues for various target groups.

Efficiency of Energy End-Use

An energy conservation office has been set up in VRA. Household sector as the largest energy consumer has also the largest potential to save energy through energy efficiency practices. Programs in the charcoal

cycle, firewood and charcoal stoves are being actively pursued by NEB. Substitution of LPG drive in households, public institutions and small industries is working well. Efficient air conditioners in Ghana's condition are being promoted to cut down on electricity use in addition to architectural features for energy saving. Trained Ghanaian consultants are now performing energy audits for industrial establishments that has started, yielding considerable savings in petroleum and electricity. Plans are in progress to control fuel saving measures in the transport sector.

Private Sector In Energy

Reforms in the ERP has resulted in an open door policy for the private sector. Private sector financing and firm are dominant in Ghana's petroleum, electricity and biomass energy subsectors. Concerted efforts by the government are still going on to attract private sector to renewable energy subsector for indigenous research and technology development.

AID and Other Donor Activities in Energy Sector

AID had very little involvement in the Ghana energy sector in recent years. Development in the sector under the ERP requires assistance from all donors and AID program facilities of Natural Environmental and Resources and Science & Technology have much to assist Ghana with respect to forestry, environment, electrical power and renewable energy. Direct AID funding of rural electrification projects would help increase benefits from other rural projects. Other donors like the World Bank, UN agencies, CIDA, GTZ, etc have been and continue to be active in all aspects of the energy sector.

Rural Electrification

The government adopted a policy of power extension to most of the population by 2019. Under the Fifth Power Project, a National Electrification Planning Study will be undertaken to draw a scheme divided into five years intervals. Populated, developed or those areas with potential for development will be considered for expansion of electricity supplies based on economic activities such as: trade, agro-based business, industry, mining, tourism, educational institutions, etc. Meanwhile, the government is implementing electrification projects scattered throughout the country with donor assistance. Priority has been given to supplying power to the district capitals, townships of economic importance and towns within twenty kilometers of service range of grid substations of the existing electricity network. The government produced a work program for 1989-91 that will serve all district capitals either by grid extension or diesel generators. Apart from the funding problem for the electricity extension, there are also problems of the ability of the rural population to regularly pay for their electrical consumption and also lack of complementary infrastructures, that together with electricity will promote perceived socio-economical growth.

The Private Sector in Energy

The execution of the Economic Recovery Program of Ghana has involved considerable input from the private sector from both in and outside the country. The government's investment code has been geared particularly at attracting foreign private investors. The government has become more open to private participation in the economy particularly in the form of partnerships and this has been manifested in the energy sector.

In the petroleum sub-sector, the government has been trying to stimulate the private sector in exploration, development and exploitation of hydrocarbon basins in the country. A number of private foreign oil companies are actively engaged in all aspects of the petroleum industry and this is expected to increase in the future. Though, VRA and ECG are state-owned organizations, execution of most of the work in the power sector is undertaken by private sector firms. Currently, the government is encouraging electrical materials manufacturing firms to establish factories in the country that will produce most of the electrical transmission and distribution needs of the country. In the fuelwood cycle which forms the largest energy source in the country, the private sector controls the harvesting of wood to retain marketing. The end-use equipment is also in the hands of private entrepreneurs. The current pursuits in the renewable energy drive has opened the door for private sector initiative from research for adaptable technologies to manufacture and marketing of the energy hardwares.

AID and Other Donor Activities in the Energy Sector

AID's participation in energy activities in Ghana was in 1979 for testing solar crop dryers and in 1978-81 in participation with the Bank of Ghana, CSIR and BRN for feasilibility pyrolysis of organic residues. The GOG has been pursuing ERP with the necessary policy reforms. In the energy sector, many areas in the recovery process fit into AID's Energy Policy framework for assistance. In the management of forests for sustainable forest resources, program activities under NRM provides opportunities to develop projects that will assist GOG's effort in sustainable biomass renewable energy. NRM project will also help GOG in enforcing its policy on environmental conservation.

The GOG's policy of improving the electricity coverages of the country aim at stimulating the rural socio-economic development. This is in harmony with AID's Energy Policy and therefore constitutes a key activity worth AID assistance. This would help supplement other rural area projects that together would stimulate growth in the rural areas.

Energy Sector and The Environment

Environmental effects due to the exploitation of woodfuel, hydroelectricity and petroleum for national energy needs have been a concern in Ghana. The government has responded, in this environmental awareness era, by creating the Environmental Protection Council (EPC). With assistance from donors, the EPC has prepared an Environmental Action Plan (EAP) which was presented at a national conference in June 1989. The EAP is to result in government policy and laws that will help in protecting the environment in Ghana.

The country has, however, been involved in reforestation and efficient woodfuel energy cycles to reduce deforestation. The government has also been involved in the diversification of energy source in order to move the population from overdependence on woodfuel. As poverty is one of the root causes of environmental degradation, the government is pursuing rural electrification in order to access rural areas with inexpensive energy that will stimulate rural economic growth thereby contributing to environmental preservation.

conclusion

The analysis of the energy sector in 1990 shows an advanced progress accomplishment in the implementation of recommendations made in the UNDP/World Bank Assessment Report of 1986. The National Energy Board has been playing its role creditably in coordinating activities in the sector. Technical assistance and local experts have provided in-depth

studies in the various energy subsectors that have helped shaped the governments energy policies and prepared fundable projects for donor and private sector financing in the Public Investment Program. Institutional strengthening efforts are giving the expected impacts which are mainifested by marked improvmement in performance of the sector. The main constraint to rapid recovery, in the sector, is funding shortfalls or delays. Currently, the energy sector is taking the leading share of the total Public Investment Program under the ERP. The government's openess to private participation in the sector and concern for the environment with respect to the sector activities is laudable. The progress of improvement in the sector indicates that the government's target for energy sector growth rate is attainable and will support expected GDP growth with appropriate sustainable energy mix.

GHANA ENERGY SECTOR

1. COUNTRY BACKGROUND

The Republic of Ghana is situated on the coast of Guinea in West Africa and lies between Togo to the east, Burkina to the north, Cote D'Ivoire to the west and the Atlantic ocean to the south. The country, a former British colony, gained independence in 1957. The land area comprises about 238,500 sq km divided into ten political regions. In 1984, the population was estimated at 12.3 million.

Most of the country lies less than 300 meters above sea level with a small area to the east rising above 500 meters. Seventy-five percent of the land is covered by high forest and woodland savanna. The climate of the country is predominantly influenced by southwest Monsoon winds and Harmattan winds from over the Sahara. The annual rainfall varies from 2,250 mm in the west coastal area to about 1,000mm in the north of the country. The mean annual temperatures ranges from 27°C to 29°C and the relative humidity from 90 percent along the coast to 20 percent during the dry season in the north.

Although Ghana is said to have rich natural resources, its economy has been heavily dependent on agriculture. Peasant farmers, with average holdings of 2.5 hectares, play the greatest role. The main export, cocoa, constitutes over 60% of the country's export earnings. This is followed by mining and timber industries. In the 1960s, Ghana embarked on rapid development giving it the highest GNP per capita south of the Sahara. This was followed by a period of economic and political upheavals resulting in a serious decline and deterioration in the country's production and infrastructure. The situation drove some part of the population out of the country and among other things affected the retention of qualified manpower for key economic and administrative sectors. During this period, the literacy rate, which hitherto had been one of the highest on the African continent, dropped considerably. It is presently rated at 55%.

Politically, Ghana's experiment with various governments did not succeed in providing the required stability. Instead, the result was internal upheavals and a depressed economy, which was exacerbated by the oil crisis and low commodity export prices. However, with the advent of the Provisional Defense Council(PNDC), relative stability has been enjoyed by the country since 1982. The PNDC is the highest policy-making authority and is composed of ten members headed by a chairman who holds executive power. Secretaries, who staff the various ministries, make-up the Committee of Secretaries charged with making certain policy decisions and recommendations. Pursuing decentralization, the ten regions enjoy some autonomy and are headed by regional secretaries. The recent institution of elected district assemblies, offers districts the opportunity to plan their economic and social development using democratic principles.

Between 1970 and 1982, per capita income declined over 30%; import earnings dropped by over 30%; real export earnings decreased by over 52% and the national consumer price index rose from 19 in 1973 to 2367 in 1983 or by over 12,358% against a 1977 base index of 100.14/ By 1981, almost 40% of the foreign exchange earnings was spent on petroleum imports, placing severe restraints on the country's ability to secure other essential imports for national development. Ghana's energy situation deteriorated further in 1983-84 when an unexpected and prolonged drought seriously affected electricity generation provided by hydroplants (which produce about 94% of the country's electricity). There were massive cuts in domestic electricity supply and a total halt to electricity export. These factors accelerated the decline in industrial output and worsened the general overall economic situation. (Annex A-1 illustrates the trends of economic indicators for the country during the period 1980-86.)

The relative stability in the country has permitted continuation of the Economic Recovery Program (ERP) launched in 1983. When the program was initiated, the energy sector was given due attention for its key role in the economic recovery and growth sustaining activities outlined in the the ERP.

The initial stages of the program aimed at reforms in the currency exchange rate, adjustment in income distribution, strengthening several export avenues and improvement of the infrastructure. This has reversed the downward trend in the economy. The second phase of the project, which started in 1986, gives emphasis to the rehabilitation of the country's infrastructure sectors that will sustain economic growth. This has seen increasing support and involvement of the international financial community led by the World Bank. The program requires substantial technical assistance and injection of foreign capital through investments that will boost the economy and generate employment. The hardest part of the program has been strict policy reforms, which the government has done well in satisfying. Adverse impacts, such as further decline in the already unsatisfactory living standards of the general population and continuing low export commodity prices, continue as major retardants to a speedier economic recovery.

2. ENERGY RESOURCES

Ghana is endowed with substantial natural energy resources. It has relied on two main indigenous sources namely wood fuel and hydropower in meeting most of its energy requirements. Wood is abundant in the high forest and savanna woodland which together cover about 75% of the country's land area; it accounts for over 78% of the estimated total output. The heavy dependence on wood fuel, virtually the sole form of energy use by a majority of the rural population (85%), and the increasing trend of charcoal consumption by a rapidly increasing urban population, has begun to make growing demands on wood fuel sources. The northeastern part of the country is already experiencing fuel wood

scarcities as a result of this phenomenon. The savanna woodland has emerged as being most vulnerable to such demands which are contributing to the uncontrolled deforestation with implication for environmental degradation.

The hydroelectric potential, that is considered technically exploitable in Ghana, is estimated at 2,000 MW and is derived from three major river systems (Volta, Pra, Tano). Although other potential sites identified they are presently, considered financially unattractive with respect to thermal alternatives at low fuel prices. Small hydro potentials exist and, at present, approximately 40 sites have been identified. The two existing dams on the Volta river (with an installed electricity generating capacity of 1072 MW) supply about 20% of domestic energy output. Thermal plants installed mainly in the large towns, provide about 88 MW of electrical energy.

Petroleum products, which account for about 23% of the nation's energy consumption, are obtained from imported crude oil. This has absorbed most of the country's export earnings. Prospective hydrocarbon deposits in Ghana are located in approximately 104,000 km of onshore sedimentary basins and about 70,000 km of offshore sedimentary basins as well as deep offshore basins. Deposits of crude oil and natural gas have been identified at three offshore areas; Saltpond, Tano and Cape Three Points but their sizes have yet to be determined.

Solar energy is abundant in Ghana with most places receiving more than 1,900 hours per year of sunshine. A number of technological studies are in progress to exploit this potential.

3. ENERGY SECTOR ORGANIZATION AND INSTITUTIONS

3.1. General

Energy institutions in Ghana, can be placed in two groups namely; utility agencies or research oriented institutions. The utility agencies are responsible for production, distribution and management of energy resources and related services. Apart from the distribution of petroleum products, which are in the hands of private companies, the utility agencies comprise a small number of semi-autonomous state enterprises (Ghana National Petroleum Corporation, Ghana-Italian Petroleum Company, Ghana Oil Company, Volta River Authority, Electricity Corporation of Ghana). These enterprises have several years of operation and a high calibre of staff who deal principally with petroleum and electricity. Despite the predominant position of woodfuel in the country's energy resources, there was no central utility to coordinate its development and use until the formation of the National Energy Board in 1985. Energy research activities were centered around the three universities in the country and a few of the institutes under the Council for Scientific & Industrial Research (Food Reasearch Institute, Industrial Research Institute).

The energy sector has been reorganized and its role expanded into the following four areas:

1. The National Energy Policy & Planning Authorities: Responsible for formulation, coordination, monitoring and review of policies and programs for the overall development & use of energy resources to meet established socio-economic priorities;

2. The Major Energy Supply Utilities: Responsible for the implementation of suppy policies in conjunction with overall national energy requirements and priorities;

3. Sectoral Socio-Economic Institutions: Responsible for assessing the requirements and mix of energy consumption in their own sectors and projections of future energy needs in relation to the prioritized developmental objectives and targeted growth rates for the sectors;

4. Academic & Research Institutions: Responsible for articulating and implementing a range of research activities to meet the identified needs of the other three, as well as refining the tools for integrated evaluation of policy options for changing circumstances.

3.2. The Ministry of Fuel and Power (MFP)

The ministry has principal responsibility for development and implementation of energy policy in Ghana. It supervises the activities of the major national energy establishements namely:

- National Energy Board (NEB),
- Volta River Authority (VRA),
- Electricity Corporation of Ghana (ECG),
- Ghana National Petroleum Corporation (GNPC),
- Ghana Italian Petroleum Company (GHAIP) and
- Ghana Oil Company (GOIL)

A Secretary appointed by the PNDC is responsible for the Ministry and presents all policy matters requiring higher authorization to the Committee of Secretaries and the PNDC.

3.3. The National Energy Board (NEB)

The Board was established in 1985 to be the overall policy formulation and coordination agency for energy matters in Ghana.9/ Its main functions are:

1. to formulate overall policy on energy for consideration and approval by the government;
2. to assess the country's resources and monitor the operations of the public bodies responsible for energy development and utilization in Ghana.
3. to secure a firm base of comprehensive data and information on national energy resources for decision making.

The Board has also been given specific responsiblities to direct the development and demonstration of promising renewable energy resources. This includes woodfuel which provides the bulk of the country's energy needs.

Its activities are directed by a 13-member Board appointed by the government and chaired by the Secretary of Fuel and Power. NEB has 40 high level professional staff members and is empowered to appoint technical committees, which would deal with power resources, petroleum resources, renewable rural energy and energy conservation. (See Annex A-2 for NEB organization chart.) Technical assistance to NEB has been provided from UNDP, in energy planning, through resident advisors and under the IDA Energy Project for the establishment, initial operation and training for an Energy Information Center and renewable energy activities.

The "Energy Fund" is financed by levies on petroleum products and electricity as well as external donations and grants. It is used to finance the Board's operational budgets and programs, which include demonstration and evaluation studies and, projects on energy conservation, renewable energy and manpower development.

3.4. The Volta River Authority (VRA)

The VRA was established in 1961 to develop, generate and sell hydropower from the Volta hydroplants. It supplies electricity in bulk (94% of the country's electricity production) to ECG, the Volta Aluminium Company and several mines, the Akosombo Township and the Akosombo Textile Company. It also exports power to the neighboring countries of Togo, Benin and Côte d'Ivoire.

VRA is also required to develop the Volta Lake for transportation, fishing and tourism. It is governed by a board, appointed by the Head of State, and it is made up of a chairman and seven other members, including VRA's Chief Executive, the Managing Directors of ECG and VALCO, and a VRA staff member.

The VRA is a relatively small organization which has been well-managed and has enjoyed a high degree of autonomy. (Its organizational structure is shown in Annex A-3.) By the end of 1985, VRA had 2,429 employees of which 1,588 were directly engaged in electricity operations. The organization has been able to build up and retain good staff in spite of low salaries because of its financial and managerial independence, and relatively good working conditions. It maintains an active program of staff training at its own school, and staff are also sent on management programs both in Ghana and abroad.

A study of the power sector commissioned by GOG and conducted by the Electricity Supply Board of Ireland (ESB) recommended a merger of VRA and ECG. However, because of the large size of ECG and its poor state, such a merger would be premature and would overshadow the smaller and more capable VRA leading to greater overall inefficiency. Though the merger recommendation is still on the table, it is considered as a long-term objective by IDA and the government of Ghana (GOG).

In the medium-term, attention is focused upon efficiency improvement in ECG through the assistance of ESB. Also, agreement has been reached by GOG, VRA and ECG that VRA would take over all the power distribution in the NOGREX project area (i.e. roughly from north of Kumasi to the Upper Regions). This decision means that ECG would lose 2% of its market and would transfer some personnel and all fixed assets in the project area to VRA. The Northern Electricity Department within VRA has been created and has taken over the area in question.

3.5. The Electricity Corporation of Ghana (ECG)

ECG, created in 1967 to succeed the Electricity Division of the Ministry of Works and Housing, has the objective of supplying electricity throughout Ghana, except to certain specified large industrial customers who are supplied directly in bulk by VRA. The creation provided for a governing board that would also formulate policy. The Board is made up of a chairman appointed by the government, ECG's Managing Director , VRA's Chief Executive, and other persons representing government, industry and consumer interests.

Since its creation, ECG has suffered from ineffective management and has not been able to make it as an autonomous and effective public utility. Since 1985, however, the corporation has been undergoing a major reorganization with technical assistance provided mainly from the Electricity Supply Board of Ireland. A new Board is in place since 1986 to replace the previous ineffective one and a new organizational structure is being implemented to provide a satisfactory basis for ECG's development. (See Annex A-4 for the reorganized structure of operation.) With a current staff of 3660, ECG is overstaffed and suffers from the proper skills mix to function successfully as a commercial enterprise. A redundancy program has been worked out for low level skills and needed recruitment of graduate-level staff will be tackled to fill identified shortages.

ECG is one of the 14 public enterprises asked to prepare corporate plans under the IDA-assisted Public Enterprise Reform program and the Board has adopted one for the period 1988-92, which will be rolled forward annually. The Corporate Plan predicts ECG's situation at set times with focus on performance targets. A performance contract between the government and ECG incorporates key performance targets and specifies mutual obligations to the parties. For planning and monitoring of its performance, ECG has established a computerized management information system through funding from IDA.

3.6. The Ghana National Petroleum Corporation (GNPC)

GNPC was established as an automonous body in 1985 and charged with the exploitation and development of indigenous petroleum resources. In addition, it is the sole agency charged with the importation of petroleum products (both crude and refined), the re-exportation of residual oil and the supply of petroleum products to domestic distribution companies.

Together with the Ministry of Fuel and Power, GNPC negotiates contracts with foreign companies. The GNPC has received technical assistance from UNDCTC and the Commonwealth Secretariat for contract related matters and UNDCTC has been assisting GNPC in its efforts at organizational restructuring and institutional strengthening.

3.7. The Ghana Italian Petroleum Company (GHAIP)

Established in 1964, GHAIP is responsible for refining all crude petroleum oil into finished petroleum products on behalf of their sole client, the GNPC. It is, at present, wholly owned by the Ghana government. It has, since its establishment, operated on sound commercial lines and made reasonable profits from its operations. After its 23 years of operation, GHAIP suffered from deterioration of its basic equipment. Under the recovery program it is being rehabilitated and the company expanded to handle secondary conversion, giving it the flexibility to process different kinds of crude oil, both light and heavy.

3.8. Centers at the University of Science and Technology (UST)

The UST is the main national institution for manpower development and research in technology and science. It has developed into a full fledged university since 1961 and has been a principal center for energy research for the past 16 years. The university campus also hosts the following institutions which have been very active in energy research:

a) The Forest Products Research Institute (FPRI),
b) The Building and Road Research Institute (BRRI), and
c) The Institute of Renewable Natural Resources (IRNR).

(Annex A-5 covers the various UST institutions involved in energy research. Annex A-6 also list the research activities being undertaken and their status.)

3.9. Center of the University of Ghana, Legon

This was established in 1948 as a full fledged university and has the second most important grouping of national expertise for energy research. The principal centers of energy research are: Department of Home Science, Department of Physics, Department of Agricultural Engineering, Department of Food & Nutrition Science and Department of Geography. (Annex A-7 gives an overview of the activities of the various departments.)

3.10. Other Institutions

The Food Research Institute: The Food Research Institute, stablished in 1963, is part of the Council for Scientific and Industrial Research (CSIR). The focus of its energy activities is on thermal or solar energy systems for food storage and preservation. It has been working on development and field demonstration of solar crop dryers, solar cookers, water heaters and solar cooking systems.

The Industrial Research Institute: The Institute established in 1965 is part of the CSIR. It has specific responsibilities for the development and testing of industrial prototypes and new materials. Its energy activities have involved resource assessment and technological evaluation of biomass, solar and mini-hydro technologies. The Institute has been involved in the design, construction and evaluation of biogas digesters, end-use devices, solar crop dryers, hydraulic rain pumps for irrigation/rural water supply and assessments of the national resources potential for wider dissemination of biogas systems.

The Chief Conservator of Forest's Office: This office which is part of the Department of Forestry of the Ministry of Lands and Mineral Resources, has the responsibility of protecting and managing the country's permanent forest estate. It has a Forestry Inventory Unit which undertakes continuous inventory and synthesis of information for long-range planning. It is also involved in training on proper exploitation of forest resources. Since 1983, it has instituted a national tree-planting program with the aim of developing community forestry plantations outside the official forest reserves. In 1985, the Forestry Department had 528 technicians, 5,845 forest guards and 28 professional level staff members. Serious shortages of professionals have hampered effective management of basic departmental functions. Qualified staff have left the department because of low salary and allowances. Additional problems include a serious lack of working materials and effective coordination of forestry management. However, studies on the need for an effective forestry department have identified the various bottlenecks in the system to be addressed. The reorganization of the department is in progress.

The Energy Research Group (ERG): The Group, established in 1986, brought together professionals active or interested in energy issues in Ghana. Its aim is to promote a greater awareness and cohesion of purpose in the research, development and utilization of energy resources in the country. The Group has pushed to strengthen research cooperation and interaction. The ERG has established itself as the principal promoter of energy research and the instigator of national and international awareness of energy activities taking place in Ghana. It is supported by NEB and has established an annual National Energy Symposium. It produces regular newsletters and technical journals. It organizes periodic regional symposia and seminars which have been supported by several international organizations. ERG has provided an effective framework for integration and cooperation among researchers.

4. OVERVIEW OF ENERGY SECTOR

4.1. Energy Situation

In 1987, the net energy consumption in Ghana is estimated at 3.4 million toe (254kg toe per capita). Traditional fuel, made up mainly of firewood and charcoal, provides over 66% of the country's domestic fuel consumption.3/ This is obtained from the large tree vegetation which covers three-quarters of the country. With the apparent low investment and simplicity of its domestic use, charcoal supply rate in particular, continues to grow with the high rate of urbanisation estimated at about five (5) percent. Petroleum products, obtained from imported crude oil, provided 20% of domestic energy consumption.Agricultural residue (maize, oil palm, sorghum) used mainly in the rural areas, constitutes 10% of the total domestic energy supply. Electricity supply is only 3% of the national domestic energy consumption. Since 94% of the electricity supply is from a relatively inexpensive hydroplant system, its expanded coverage of the country is a priority being pursued for incleased use in the future. (See Table 1 for the breakdown of sectoral energy consumption in 1985.)

The government has set as target for the energy sector an overall growth rate of energy supply of 7.5% per annum between 1988 and 1991, and 10% per annum between 1991 and 1997. In the long term, the growth rate is set at 2% above the projected GDP growth rate.

TABLE-1

BREAKDOWN OF SECTORAL ENERGY CONSUMPTION IN GHANA IN 1985

	Agric. Resid.	Fuel-wood	Char-coal	Petrol. Prods.	Electri-city
	TONS OF OIL EQUIVALENT ('000)				(GWh)
Trans-port.	0.0	0.0	0.0	347.3	0.0
Indust./ Mining	0.0	59.9	0.0	92.7	52.3
Agric./ Fishing	0.0	40.0	0.0	100.2	0.0
Commer/ Govt.	0.0	99.9	6.8	46.1	13.8
Reside-tial	138.7	1617.2	306.0	109.4	37.2
TOTAL	138.7	1817.0	312.8	695.8	103.3

A. Biomass

A.1. Firewood

A.1.1 Firewood Supply

Some 8.6 million tons of wood (equivalent to 29 million tons of oil) are used for fuel each year . This represents over 76% of the country's annual energy consumption.15/ Approximately 3.3 million tons of wood or 38% is converted into charcoal. Woodfuel is obtained from all parts of the country and is used predominantly as firewood in the rural areas while charcoal is mainly consumed in the urban centers. It is also estimated that 2.1 million tons of wood per year are cut for timber exports and for building construction. The wastes generated by this type of exploitation could provide an important additional energy supply source though it has not yet been fully utilized. Wood wastes generated at the logging sites and the sawmills constitute 75% of the raw wood. In areas where sawmills exist, sawmill residues are used to produce charcoal mainly for local supply.

Faced with forest depletion problems, other sustitutes for firewood supply for stisfying household and small industry fuel needs are being pursuedby the government. Research activities towards this objective include: using more efficient handling methods to reduce the volume of fuelwood used, the introduction of biogas for rural/ urban poor area wastes conversion and solar power. There are additional plans to promote the domestic use of LPG (currently burned off at the oil refinery).

A.1.2 Firewood Consumption

The FAO (1983) and World Bank (1986) estimated the country's fuelwood consumption at an average of 0.93 m3/person/year. The average consumption is higher in the south. In northern Ghana, it is below the national average. It is also estimated that charcoal is consumed at an average of 140 kg/person/year (fuelwood equivalent of 1 M.T. or 1.43 m3 per person/yr) in the urban areas where about 80% depend on it as their main fuel. Based on these figures, the overall fuel consumption is estimated at 8.6 million M.T. (12.3 million m3). Of the woodfuel not converted into charcoal (i.e. 5.3 million M.T. in 1985), 89% is estimated to be consumed by households for cooking, water heating and other domestic purposes, 5% in cottage industries and 5% in the commercial/governmental sector; and 1% for fish smoking.

The UNDP/World Bank Energy Assessment Mission in 1983 reported that wood consumption could exceed the natural forest increment in the 1990s if the demand continued at the same pace (no study has determined the actual trend to 1990). Fuelwood accounts for over 95% of the energy consumed in the rural areas where it is used mainly for heating and cooking. With funding and accessibility constraints against alternative energy sources (like petroleum products, electricity, solar and other renewable energies) reaching the rural areas, firewood will continue to play a dominant role in the provision of energy to the rural population.

A.1.3 Firewood Demand

The decline in Ghana's economy in the last twenty years has also slowed down the demand rate of commercial energy use in general. This has been due mainly to shortages of the supply. Firewood became a dependable source and its demand is increasing due to both urban and rural growth rate.

The resulting heavy dependence on traditional fuelwood has created a steadily increasing demand. However, despite this general trend, the northeastern part of the country has a suppressed demand of firewood because of its relatively high-cost and scarcity in some areas.

The World Bank (1985)15/ advanced two scenarios for energy demand forecasts for the country for the period 1985-1995, one based on trends and the other action-oriented. The action-oriented scenario estimated fuelwood consumption to increase at 1.2% p.a. in 1986-90 and at 0.5% p.a. in 1991-95 reflecting the assumption on conservation and substitution of fuelwood in households. In the trend-based scenario, consumption will increase by 3.6% in 1986-95 p.a. The share of fuelwood consumption during 1985-95 would decline from 69% to 61% under the action-oriented scenario and to 62.5% under the trend-based scenario (no study is available in 1990 on actual trends).

A.1.4 Firewood Prices

The prices of fuelwood are market-determined with no governmental intervention. With most commodities, in Ghana in the past, government regulations and market imperfections decide prices rather than international price trends or cost considerations. Firewood prices fluctuate with imperfections in the harvesting to marketing systems due to too many intermediaries, lapse in transportation schedules, handling losses etc. Firewood is harvested and sold by farmers, wood choppers and Forestry Department at roadside prices of ¢160-¢800 solid m3 depending on distance from consumption centers.15/ The cost of felling, crosscutting and transportation to roadside is about ¢200 - ¢400 per m3 depending on the distance to the nearest road. The Forestry Department levies a stumpage fee of about ¢12/M.T. Retail prices vary considerably according to the distance from the supply source and the volume of the wood traded. In the northern part of the country and around Kumasi, the bulk price of a truck load ranges from ¢0.5/kg at the road side to ¢2/kg near town. Accra also has a correspondingly higher retail price.

A.1.5 Constraints on Increased Production

A number of constraints militate against fuelwood production to meet the increasing consumption trends in both rural and urban areas without depleting the forest. Some of these emanate from ineffective forest management. The total accessible wooded area in Ghana is estimated to be 10 million ha with a mean annual increment of 0.75 m3/ha/yr. The vegetative growth rate still exceeds the consumption rate but the gap is narrowing fast and it is expected to be exceeded with current trends in the 1990s. Some of the constraints against production of firewood in the face of increasing consumption trends in both rural and urban areas are:

1. Drought and fire damage, like that during 1983-84, which destroyed a substantial portion of the forest and retarded tree growth, reducing regeneration.

2. Deforestation and range degradation, due to population pressures, characterized by uncontrolled and wasteful wood harvesting.

3. Overgrassing and overstocking of livestock which has reduced vegetative growth for fuelwood.

4. Preoccupation with short-term benefits from increased agricultural and timber production have tended to have priority over the need to protect and develop the forest for fuelwood.

5. Indiscriminate burning of grass in the savanna zones during the dry season which destroys young trees and retards tree growth.

6. Insufficient road infrastructure in the firewood production areas adversely affects the firewood exploitation system.

7. Institutional and policy weaknesses restrict the effectiveness of forestry resource management (e.g., stumpage fees for fuelwood harvesting in forest reserves are too low to cover the cost of the management of stumpage control).

8. Lack of interorganizational coordination and cooperation have rendered the fuelwood supply strategy implementations ineffective.

9. Lack of sustained government and popular commitment to policies which prevent over-exploitation of accessible forests through protection, yield regulation and reforestation.

A.1.6 Options for Increased Production

In order to meet future energy needs through the use of firewood and at the same time preserve the country's forestry potential, the government has taken steps to tackle certain inherent problems. The government's objects are:

a. create and maintain sufficient permanent forestry resources,
b. manage these resources by methods ensuring maximum productivity, and
c. optimize the use of the resources outside the forested areas.

In order to attain these objectives the following strategies have been identified in the UNDP/World Bank Assessment Report of 1986:

1. The strenghtening of the Forestry Department through more adequate resources and manpower development.

2. Modifications of forestry taxation to stimulate efficient resource use and allow the government to finance a larger share of tree planting through its own funds.

3. Preparation of a fuelwood development plan, as part of a land use plan, based on:

   (i) realistic assumptions about the productive potential and future demand,

   (ii) selective inventories of forestry resources within reasonable distance of major consumption centers,

   (iii) evaluation of options to increase accessibility to forests, and

   (iv) woodfuel consumption surveys in major consumption centers.

4. Evaluation of least-cost options for securing fuelwood supplies over the longer term based on:

   (i) a combination of government, community, and private sector participation;

   (ii) stronger involvement of local communities in managing forestry resources;

   (iii) selective establishment of fuelwood plantations in areas of particular importance for woodfuel supplies; and

   (iv) assistance to charcoal producers to increase productivity.

5. Changes in land management, based on an integrated approach to the interaction of forestry, agriculture and pastoralism, both to reduce forest over-exploitation and to increase agricultural yields.

6. A research program aimed at:

   (i) developing technical packages and selecting species suitable for tree planting in conjunction with cropping or grazing,

   (ii) using wood residues more efficiently, and

   (iii) developing markets for tree by-products.

Government programs and development projects incorporate the above stratergies.

A.1.7 Institutional Involvement

The newly created NEB, has been charged with providing baseline information on energy sources and uses as well as planning methodologies. It has been actively engaged in the Rural Integrated Energy System (RIES) through series of micro-level rural energy studies. Studies have already been initiated in critical areas of concern for fuelwood supply shortages. The NEB has been strengthened with specialists and materials, and has been coordinating the activities involving all aspects of fuelwood as well as other energy sources in Ghana.

The Forestry Department, which should spearhead forest resources management for adequate supply of fuelwood, was ineffective in the past. Under the ERP, serious efforts are being undertaken to make the Department effective. Because of the heavy dependence on fuelwood, the reactivation of the Department constitutes the highest priority in the energy sector. A reformed Forest Department should be able to extend its activities outside traditional forest reserves into the unreserved forest and savanna zones by improving land use. The Foresty Department should decentralize, locating their centers of actions in districts where initiatives, such as tree planting, are taking place. Regional and head offices would then act as relevant supports.

A.1.7.1 Institutional Cooperation and Coordination

The newly created National Energy Board provides a broad organizational role in the energy sector. This has significantly improved coordination with various sector organizations. Additionally, other organizations like Ghana Highway Authority and Feeder Roads Department should be included in planning for the provision of vital access to potential fuelwood areas.

Coordinating with the communities in planning and implementation of woodfuel activities would also foster understanding, cooperation and productivity from the public.

A.1.7.2 Forestry and Savanna Inventory

In order to develop the appropriate fuelwood strategy, comprehensive up-to-date forest and savanna land inventories are vital. Little attention has been paid to the unreserved savannas in the past, though the largest fuelwood harvest takes place in the savannas. Therefore, there is the need to determine long-term sustainability in view of slow growing tree vegetation. With modern advances in satellite imagery technology, inventories could be conveniently undertaken with technical assistance from institutions like the USDA-Forest Service or similar ones which have excellent facilties.

A.1.7.3 Forestry Financing

The stumpage fee charged by Forestry Department on fuelwood was ¢12/M.T. This fee should be increased in accordance with the cost of collection and the long-run marginal cost of fuelwood production from plantations.

A.1.7.4 Tree Pl ..ng

Forestry Department: The Forestry Department should continue tree plantations in the forest reserves, strengthen its support for extension services and supply seed and seedlings to enable tree planting by other non-governmental entities.

Rural Communities: In line with the strategy of the Ministerial Conference for Concerted Policy in the Struggle Against Desertification and the Protection of Nature in West African Countries, mass mobilization for tree planting has been initiated in many West African countries. In Ghana, the Forestry Department has set up a target of 3,000 hectares per year of rural tree planting. To succeed in attaining this target, steps must be taken to:

(a) involve the local populations in project planning and to give them ownership of trees planted,
(b) provide effective extension and
(c) ensure that benefits (e.g., fruit, fodder, etc.) other than from fuelwood are generated.

The Forestry Department needs to conduct studies on optional methods for promoting tree planting suitable species and results tested on actual farm situations for dissemination. Selling of seeds and seedlings should also be studied. Rural farmers are better acquainted with Agricultural Extension Officers than those from the Forestry Department. Consequently, tree planting extension work should be provided by Agricultural officers with the necessary technical support from the Forestry Department.

Farmers should be encouraged to plant trees for their own needs and for harvesting as fuelwood for revenue. Harvesting could be undertaken during agricultural off-seasons. Local communities should be helped to establish woodlots near towns and villages for convenient proximity.

Private Commercial Involvement: The fuelwood market potential has been important and will continue to be so into the near future as the larger population of the country maintains dependence on fuelwood for most of their household and small business energy needs. The private sector needs to be stimulated to go into privately owned fast yielding firewood trees for commercial exploitation.

A.1.7.5 Harvesting of Firewood

Destruction of trees could be reduced by selective harvesting of tree branches that will allow the tree to regenerate new branches. With adequate access roads provided in both reserved and nonreserved forests, substantial dead wood could be harvested, thus reducing the potential fire hazard of dead wood concentration.

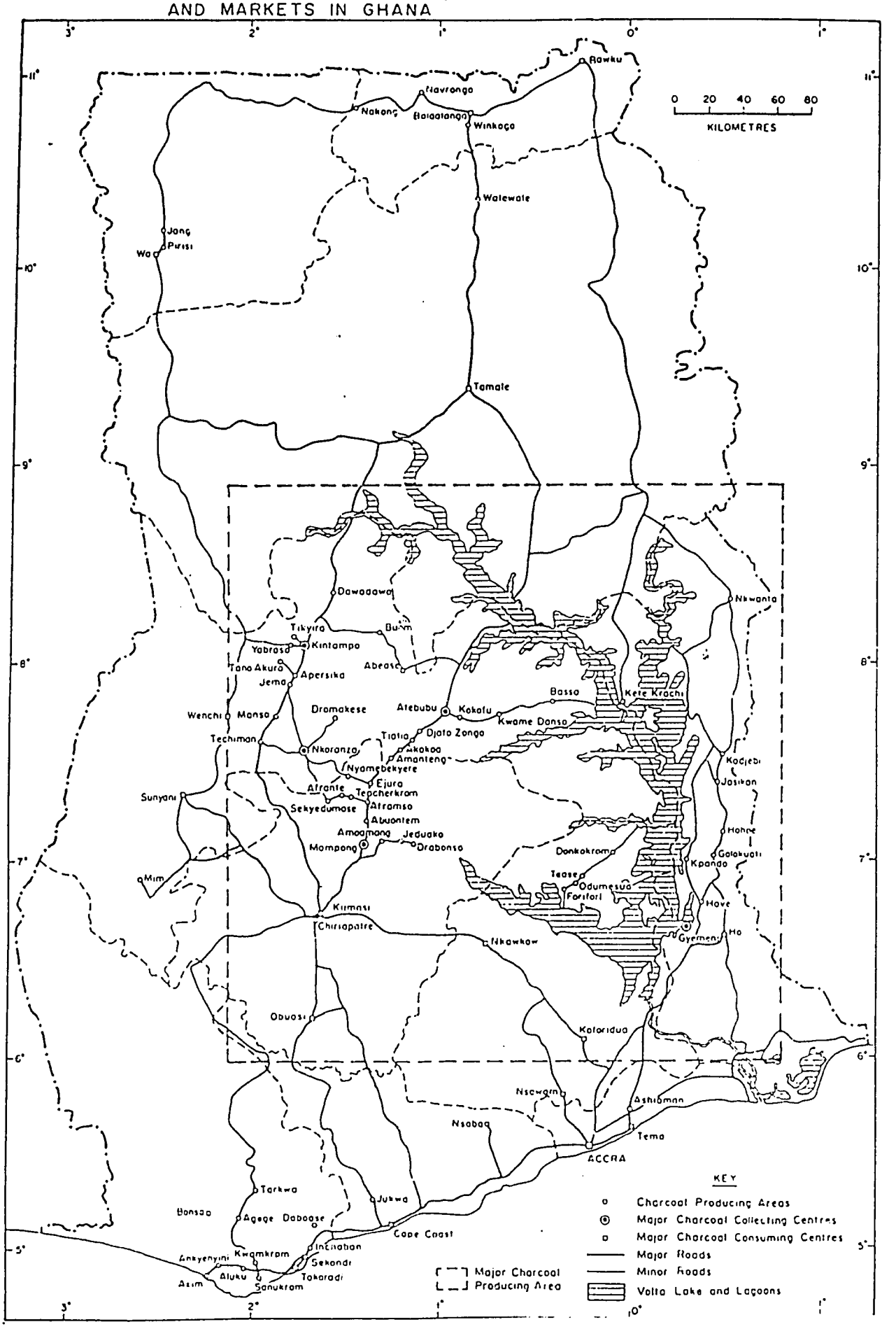
A.2. Charcoal

A.2.1 Charcoal Supply

Charcoal production (as shown in Table 2) in Ghana is concentrated mainly in the savanna woodland areas in the regions of Brong-Ahafo, Ashanti, Eastern and Volta.2/ Kumasi and Accra are the main markets for these zones which are located 100 to 500 km away. Some charcoal is also produced in the rain forest in the Western Region for sale in Tarkwa and Takoradi. In the Central and Eastern Regions the production from the semi-deciduous forest is marketed in Koforidua and Cape Coast respectively. Where large sawmills are found as in Kumasi, Mim and Akim Oda, charcoal from sawmill residues is sold locally. On the average, 79% of charcoal to urban areas comes from the savanna zone, 15% from the moist semi-deciduous forest and 6% from the rain forest. (Annex A-8 and A-9 shows the list of producing areas, transportation routes and the main markets.) Charcoal production is done mostly along motorable roads in forest zones. In savanna zones, cleared tracks are usually adequate access for trucking to and from production areas. In the Afram Plains and in the Eastern Region, charcoal is transported on the Volta Lake to the port of Gyemini where it is then trucked to Accra.

Table 2

MAIN CHARCOAL PRODUCING AREAS, TRANSPORTATION ROUTES AND MARKETS IN GHANA



Charcoal is produced mainly from selected live tree species on fallow lands and some farms in the savanna and rain forest. Limited production is allowed in the forest reserves. The production is done by small scale producers usually in groups of 5-10 persons. The Forestry Department also produces a very limited amount. The production is done mostly by the earthmound method but there have been drives for changing to more efficient production methods like the use of steel and casamance kilns. However, the high initial cost of the kilns and the difficulty of moving them from site to site have restricted general use.

A.2.2 Charcoal Consumption

In Ghana, charcoal is obtained from approximately 3.3 million tons of wood or about 38% of the national annual consumption of fuelwood.15/ It is the predominant domestic fuel for about 69% of the urban households. It is estimated that 476.8 thousand metric tons of it is consumed annually in the urban centers of the country.2/ The national per capita consumption is put at 180.8 kg per annum. Accra alone consumes about 30% of the annual national consumption. (The table in Annex A-10 displays the annual consumption for major urban areas in the country.)

Charcoal is one of the most expensive household fuel options but it remains the dominant fuel used by all the income groups of the population. This is because:

1. Even though urban areas might have electricity, unreliability and sometimes limited periods of supply discourage people from relying on it.

2. The initial high costs of electric cooker/stoves cannot be afforded by many people.

3. The butane gas (LPG) supply has been limited and even where available, its use requires a substantial investment in the gas cylinder and stove which few households can afford.

4. The inherent dangers in the use of electricity and gas also scare people from using them for cooking.

5. Unreliability of kerosene supply, its unfavorable scent and the relative high cost of the stove discouraged general household use.

6. Charcoal supply is quite reliable, its use is controllable and the burning is clean as well as fast. Its favorable taste to food, gives it a strong traditional craving.

7. Charcoal use requires very little initial upfront money for the stove, it is very simple to use, and can be bought in small quantities at any time.

In general, the choice of household fuel depends more on safety and speed of cooking rather than on its cost or convenience.

A.2.3 Charcoal Demand

The urban area depends heavily on charcoal and this dependency is expected to continue for the foreseeable future. The demand is, therefore expected to increase in line with the rate of urbanization (put at 5.3% per annum). The charcoal trade network, a well-organized informal sector, is considered to be able to meet the demand trend.

The UNDP/World Bank Energy Sector Assessment of 1986 projected charcoal demand for 1985-90 and 1990-95 on the basis of Trend-Based Scenario and Action-Oriented Scenario. The growth rates were applied to 1985 net domestic consumption. (Annex A-11 contains the projections for charcoal demand in the two scenarios for urban household. Annex A-12 indicates the total charcoal requirement under the two scenarios.)

The demand for charcoal is expected to increase in the foreseeable future because:

- the essential economic needs and independence of outside events requires that the country rely on its indigenous energy resources for sustained future development and charcoal provides a simple answer;

- urban growth rate continues to increase; and

- well entrenched socio-cultural beliefs and cooking practices with fuelwood, in general, may not change easily.

A.2.4 Prices

Charcoal prices, as in the case of firewood, are market-determined with no government intervention. The prices vary considerably from urban center to urban center according to supply distances, demand situations, the general cost of living and charcoal quality and type. Prices can vary significantly within the same urban area. Charcoal from the same zone of production usually sells at the same price in an urban center irrespective of the supply distance.

The market is well-organized involving producers, transporters, wholesalers (in urban areas who receive charcoal by truck load and resell relatively large quantitities), and retailers selling to individual consumers. (Annex A-13 shows the sources and prices of charcoal in the regional capitals.) Some organizations like the Ghana National Trading

Corporation and the Ghana Food Distribution Corporation also trade in charcoal. Their well-established organizational structures and infrastructures have enabled them to sell charcoal to consumers at relatively lower prices. This is, however, serving only a limited market.

As mentioned, charcoal is about the most expensive household fuel among the options available in the country. The average urban household spends about 10% of its daily food cost on charcoal, if charcoal is used for cooking. Charcoal prices continue to increase rather rapidly in the major urban cities; over the period 1986-88, the prices in the cities have risen over 100%.

A.2.5 Institutional Involvement

The National Energy Board is the principal organizer of improvement activities in the charcoal cycle. The Board has initiated studies and projects involving charcoal, and has been coordinating activities involving charcoal by other institutions. The Board has an ongoing program (1990)9/ concentrating on:

1. Demonstration and evaluation of an improved charcoal making technique - the casamance technique - to traditional charcoalers in the transition (from forest to savanna lands) zone.

2. Demonstration and evaluation of the casamance and beehive kiln techniques around the sawmills in Kumasi, using sawmill residues.

3. An examination/investigation of the prospects for using logging residues from timber operations for charcoal making and also relocation of charcoal making operations from transition zone to the intense timber operation areas in the forest zone.

4. Improved charcoal stoves program.

A number of research activities with respect to charcoal has been undertaken by the universities in Accra and Kumasi. Other institutes, like the Forest Products Research, the Building and Road Research, and the Industrial Research Institute of CSIR, the Food Research and the National Vocational Training have also been involved with charcoal programs.

A.2.6 Constraints on Economical Production and Use

1. The major part of charcoal production (79%) is from the savanna zone where charcoalers search for only a few specific species which are sparsely distributed. These species continue to be found at greater and greater distances which result in higher supply costs.

2. Not much work has been done to identify other suitable wood species apart from the traditional ones like anageious leiocarpus and terminalia avicenioides. In the savanna zone, growth rate of these favored species is very low. The favored species are thus disappearing fast, a situation which is leading to difficulty in charcoaling with the consequence of rising costs. Out of tradition, lack of knowledge or information, charcoalers limit their carbonization to a few species.

3. Only 6% and 15% of charcoaling takes place in the forest and semi-deciduous forests, respectively. Not much charcoaling takes advantage of the faster regenerating rate of trees and their higher density in these areas for more economical production.

4. The country's charcoal needs are produced from the predominantly used, traditional and inefficient earthmound kiln.15/ The conversion efficiency estimated at about 18% on weight basis or 32% on an energy basis is even lower when the wood is not dried sufficiently prior to carbonization.

5. Ownership problems, in the current land tenure practice, makes it difficult for people to establish tree plantations on land belonging to others at vantage village/town vicinities for proximity access for charcoaling.

6. The charcoalers are independent private gangs who have not benefitted from any training in economical charcoal production methods.2/ They have not been exposed to the environmental consequences of their traditional methods. They do not replant trees.

7. The traditional popular "coal pots" used as cookstoves have relatively low end-use efficiencies thus also contributing to the high cost of charcoal for household cooking in the country.

8. Degraded road network in the charcoal producing areas and connections to urban center markets result in damages to charcoal trucks and delays which add to the supply cost through high transport charges.

9. Transportation of charcoal is not well organized. There are long waiting periods for loading and unloading. Returning empty to the production site also tends to increase overall transportation costs.

10. Logging and sawmill operation leaves about 75% of the wood as waste. The relationship between the timber industry and other users of the wood has not resulted in full utilization of these residues to boost charcoal production.

11. The Forestry Department has not been sufficiently equipped in the past to manage charcoal production. The result is a charcoal exploitation cycle that is uncontrolled and inefficient. Changing such an entrenched system would be difficult and time-consuming.

A.2.7 Economical and Environmentally Sound Alternatives

The heavy dependency of the urban population on charcoal,the inefficient cycle and the continued environmental degradation due to the uncontrolled exploitation of trees for charcoal, merit priority attention and a long term strategy. The NEB has been coordinating various institutions working on charcoal production and use, and has been working with the UNDP and the World Bank to improve the cycle in Ghana. The government policy framework is also in place.

Some of the steps needed to be taken in Ghana to sustain the supply are:

1. Improvement of the Forestry Department for management of national forest by the initiation and coordination of a tree planting program, and regulation of tree felling both outside and inside forest reserves.

2. Control over trees outside the reserves including the collection of fees on charcoal harvesting needs to be transferred from the Lands Department to the Forestry Department. The Forestry Department is better equipped to monitor the depletion of trees for charcoal production, and to take remedial measures.

3. Planting of fast growing trees especially for charcoal production along accessible roads and settlements should be actively promoted. The local communities ought to be made responsible for these plantations with seeds/seedlings and extension services provided by the Forestry Service.

4. Undertaking studies into charcoal properties of different types of potential charcoal-making trees is needed.2/ This will help identify other species for charcoal making. Such studies could establish a basis for classifying charcoal into groups for other possible end-uses, (e.g., industry). Quality standards could also be established for possible export markets.

5. Encouraging private entrepreneurs to go into woodlot establishment for large scale commercial charcoal production for national market and possible exports.

6. Organizing charcoal producers into cooperatives where it will be easier to expose them to improved production techniques in technology. Such cooperatives would have easier access to assistance from banks and other institutions.

7. An educational campaign to reduce charcoal consumption by changing inefficient cooking/heating habits of the population and popularizing more convenient and efficient charcoal cookstoves.

8. Determination of economic stumpage fees that could help support the charcoal production improvement program by the Forestry Department.

9. Encouraging interorganizational cooperation with other departments like the Highways and Feeder Roads so that planning of vital access for charcoal harvesting is properly considered. Good access roads would substantially reduce transportation costs.

10. Coordination between the energy institutions and the logging/sawmill operations should be instituted so that logging/sawmill residues which are not exploited presently could be turned into another charcoal energy source.

A.3. Agricultural Residues

Agricultural residues, as an energy source, are predominantly used in rural areas mostly on small settlements or on farms. The common sources are from maize, oil palm and sorghum. In the Northern and Upper Regions of the country, fuelwood scarcities are driving the population to use their crop residues. In general crop residues are harvested or obtained for free. However in these areas, the residues are now traded commodities.

It is estimated that about 3.6% of domestic energy output comes from agricultural residues (on the average for the country). In the northeast part of the country, crop residues (made up of mainly millet stalks) constitute the major energy source for cooking and heating as a result of severe shortage of fuelwood. A preliminary evaluation of the report on the studies conducted in the northeastern of the country by University of London on behalf of NEB also point to the fact that the harvesting of the crop residues is worsening the problem of soil fertility. This is because the residues are no longer available for soil enrichment.

A.3.1 Options for Agricultural Residues for Energy

1. Agricultural residues should be harvested for energy only when they would not be serviceable in the agricultural cycle.

2. Whenever crop residues are harvested, as in northern Ghana, care should be taken to maintain the field and prevent erosion activity.

3. The vital role of crop residues in the practice of shifting cultivation should be safely guarded.

4. Other suitable energy sources have to be identified for the areas obliged to turn to agricultural residues so as to encourage a shift from the use of crop residues. Electricity, biogas and solar power offers alternative energy sources.

A.4. Biogas

A.4.1 Supply

The combination of rapid urbanization and poor resources to deal with it have led to the spontaneous creation and expansion of urban shanty towns. Costs of conventional sewerage, waste and water systems, are enormous. The situation has deteriorated because the country has been unable to meet these needs. Recent advances, in the use of anaerobic digestion of human and municipal wastes to generate biogas, has become an attractive energy option for these towns.

Ghana, through the program of NEB, is currently demonstrating the biogas supply from animal waste at Appolonia, a village in the Greater Accra area.9/ In another village, Okponglo, a suburb of Accra, the biogas demonstration is based on human waste. Two digesters (50-cubic meter) are connected to a KVIP latrine. The first pilot project was undertaken on a cattle ranch at Shai Hills using animal waste. It was a successful project. (Tabel 3 illustrates biogas potential in the country by regions.)

Table 3

BIOGAS POTENTIAL BY REGION

Region	% Cattle	% Pigs	Potential
Northern	3.5	16	***
Upper West	22	23	***
Upper East	19	7.1	***
Greater Accra	8.9	6.2	**
Volta	8.1	8.3	**
Brong Ahafo	3.5	17.6	*
Eastern	2.2	6.9	*
Ashanti	9.57×10^{-3}	6.2	*
Central	4.98×10^{-3}	3.5	*
Western	4.3×10^{-3}	5.8	*

The above evaluation of biogas potential is based on availability and recoverability (effective availability of only livestock and piggery waste.

*** = Very High
** = High
* = Less important

A.4.2 Consumption

The government has, as a high priority the diversification of traditional fuel sources. Biogas, as a rural-based energy source, is being pursued to provide energy for domestic, small and medium-scale industries. The biogas promotion is thus aimed at accelerating rural development, one of the priority objectives of the Economic Recovery Program. Biogas is looked on as a way of alleviating the pressure on forest resources in order to contain the foreseeable shortage of fuelwood. It is expected to enable rural communities to become self-sufficient in energy. The consumption of biogas would provide energy, high value fertilizer, and resolve some sanitation problems.

A.4.3 Biogas Strategy

The NEB is aware that the transfer mechanism of biogas technology is greatly influenced by social and cultural factors.9/ Though the biogas generation from human feces is a welcomed solution for shanty town sanitation improvement, (with an enriched by-product as fertilizer, the use of the gas for cooking or fertilizer) for growing crops poses acceptability problems. The aim, therefore, is to overcome this taboo so that biogas can become a serious renewable energy option to meet the future needs of the urban poor. (See Table 4 for Bio-Gas Based Research Activities in the country.)

Table 4

BIO-GAS BASED RESEARCH ACTIVITIES

Executing agency	date	Place of installation	Type/No.			Haterial of Construction	Capacity (M3)
			Indian	Chinese	Othe.		
IRI (CSIR)	1980	IRI (CSIR)	1	-	-	oil drums	0.35
UST	April, 1982	Agric. Eng. Dept., UST	1	-	-	steel	1.15
"	"	"	1	-	-	steel	-
"	Nov. 1982	"	-	-	1	steel	2.80
FAO	Jan. 1986	Agric. Farm, U.C.C.	-	1	-	Bricks	8.0
FAO	Feb. 1986	Agric. Farm, Univ. of Ghana	-	1	-	Bricks	6.0
NEB/Chinese Government	June, 1986	Bank of Ghana Cattle Ranch, Shai Hills	-	1	-	Bricks	10.0
IRI (CSIR)	Sept. 1987	IRI (CSIR)	-	1	-	Bricks	4.0
IRI (CSIR)	Feb. 1988	Trade Fair Site, Labadi	-	1	-	Bricks	6.0
UNICEF/NYOC	1987 - 88	Tamale:					
		i) Buipiela	-	1	-	Bricks	10.0
		ii) Kalerega	-	1	-	"	10.0
		iii)	-	1	-	"	20.0
		iv) Josinoyimi	-	2	-	"	6.0; 20.0
IRI/NEB	May, 1988	(a) Apollonia	-	1	-	Bricks	10.0
IRI/ARCT	April, 1988	Pokuasi	-	1	-	"	50.0
Total			3	12	1		
			16				

The goals and objectives of the NEB 9/ are:

- To establish the biogas production in Ghana with respect to sources of material for sustained production.
- To evaluate equipment that can be re-adapted to the country and is simple to manage by the communities.
- To educate the population on the use of biogas as energy in order to eliminate cultural and social prejudices against its use and enhance acceptability.
- To train users in the technical management of the biogas system and disseminate the use of biogas in the country.

A.4.4 Constraints to Biogas Use in Ghana

As in many other countries where biogas has been promoted, biogas generation requires capital investment, a plentiful and reliable source of substrate, and a fair level of technical competence to obtain enough gas to justify the effort. Only few families can afford the capital or the necessary animal to support a house generator and the running costs. The community biogas undertaking also has the problems of the cost of the system, responsibility for operation and allocation of gas, collection of substrate, disposal or equitable distribution of the residue.

Prejudice against use of products based on human waste and even on animal waste for cooking or growing crops is quite strong in the country. It may require a long period of persuasion before an acceptance level is reached.

Biomass Demands and Projects for Meeting Demand

The Ghana Forestry Project Preparation Report by FAO (1987) projected indigenous consumption and industrial demand (which had been reviewed by Land Use and Planning Committee in 1979) as 77.12 million cubic meters by the year 2030. Table.5. illustrates the demand details.

Table 5

Wood Demand in Ghana

Utilization	Demand by Year 2030 (million cubic meters)
Logs, Lumber, Veneer	17.65
Charcoal	5.66
Firewood	11.33
Pulpwood	42.48
Total	77.12

A forest (aged 50 years) will have an averge yield of 140 m^3/ha wood thus the total plantation area required will be 550,000 hectares to meet the demand.20/ In addition, further planting would be required to meet ecological demands (watersheds, shelter belts etc.). This requires that 11,000ha per annum is planted during the period 1980-2050. However, as a result of the weakness in the Forestry Service, the rate of planting has been only 1000-2000 hectares per year. Currently few plantations are being started. Efforts are concentrated on securing resources for expansion of plantation projects. A number of small rural forestry projects have been undertaken in the Northern and Upper East Regions with assistance from ODA, CIDA and FAO.

In the 1988-90 Public Investment Program, the GOG and the British ODA under bilateral aid of 1.46 million pounds for an inventory of about 500,000 hectares of the High Forest Reserves is being continued. This National Forest Inventory program will enable a provisional 50 year production plan to be prepared. A unit to undertake inventories and analyze the results will also be equipped. A program to support the establishment of industrial forest plantations will take 110 million cedis. A project to be funded with 100 million cedis would also encourage agroforestry in the Upper East while 124 million cedis would fund Northern Region Community Forestry Project.

In conjunction with government policy to encourage maintenance and replenishment of tree cover on lands outside reserved forests, an Agroforestry Unit in the Ministry of Agriculture has been established to be responsible for agroforestry. This unit will promote and support the simultaneous or sequential use of woody perennials and agricultural crops or animals on the same land management unit. Thus, through agroforestry, farmers would combine the planting and management of trees and crops and/or domestic animals for the joint production of wood, fodder, food, etc.

The analysis of the woodfuel sources in Ghana indicates that the country is not expected to suffer from serious forest depletion. Some areas in Ghana notably around population concentrations and the northern part of the country have serious depleted woodfuel sources as well as deforestation problems. The GOG is taking diverse actions in the current Public Investment Program to help restore sustainable energy resources to these areas. A Forestry Resources Management Project (FRMP) estimated to cost $64.6 million (US) funded by IDA, ODA, DANIDA, and GOG is being undertaken.20/ The FRMP is policy reform management strengthening and institutional building of the nation's forestry resources. This project involves:

(i) managing industrial forestry production and export earnings in accordance with sustained yield policy;

(ii) promoting conservation and tree planting on farms to counteract fuelwood shortage and ecological deterioration;

(iii) strengthening the sector institutions through:

- establishment of a policy formulation, planning, monitoring and evaluation unit in the Ministry of Lands and Natural Resources;

- re-organization of the Forestry Department;

- provision for basic infrastructure (offices, staff housing) transportation and equipment and technical assistance and training needed to reactivate the Forestry Department and the Department of Game and Wildlife;

- building up the capacities and capabilities of the main forestry education and training institutions, namely the Institute of Renewable Natural Resources (IRNR) and the Sunyani Forestry School;

- adaptive research which includes the rehabilitation of the Forest Products Research Institute (FPRI) to provide guidance for management of natural forest resources, forestry for rural development, agroforestry and utilization of forest plantations.

In the face of a contemporary environmental crusade against disturbance of forests, GOG is also pursuing the following measures:

(i) Encouragement of the use of small LPG stoves in the urban areas to reduce household use of fire and charcoal. Fairly large quantities of LPG is available as a by-product from the Tema Oil Refinery;

(ii) The development and use of biogas on a larger scale;

(iii) The development of mini-hydro installations to provide electrical power to smaller communities;

(iv) The extension of hydro power to other parts of the country to provide industrial power;

(v) Development of solar power.

In northern Ghana, a Collaborative Community Forestry Initiative (CCFI) which consists of Forestry Department, Adventist Development and Relief Agency, Amasachina Voluntary Association and the US Peace Corps has started tree seedlings project at the end of 1989. The project plans to nurse a total of 9.6 million tree seedlings in the next six years as part of the national afforestation program. Nim, pawpaw, mango, eucalyptus, silk, cotton, teak and acacia are the main species for planting. The project will develop water resources near the nursuries. Plant species which give early returns and food-for-work packages for communities will form part of the project to sustain interest of participants. The project is financed through a World Bank funding.

CONCLUSIONS (SUMMARY REMARKS) WOODFUEL

Presently, the forestry resources of the country meets the woodfuel need of the population as a whole. In addition to an increasing population requirement of woodfuel in the future, the present population concentration effects in some localities on woodfuel resources areimportant concerns to the government. These concerns are exacerbated by the shifting cultivation practice and uncontrolled bush fires.

While the government is working through the PIP at restructuring the forestry subsector in general, special attention is being paid to the northeastern part of the country which is presently affected by woodfuel shortages. Not only is deforestation a problem for the country's traditional energy sources, it has regional and international effect as well. This concern is translated into the assistance the government is receiving from the World Bank and many other donors to resolve the country's forestry problems and sustain tropical forests. USAID, by co-sponsoring the conference on Ghana Environmental Action Plan in 1989 has helped to focus attention on an integrated approach to sustaining the natural resource of Ghana. The NRM project of AID is expected to offer opportunities for the country to develop projects which could be funded through local currency sources.

AID's participation in Ghana's energy activities was in 1979 for testing Solar Crop Dryers, and in 1978-81 in co-participation with the Bank of Ghana, CSIR and BRRI for feasibility pyrolysis of organic residues. The GOG has been pursuing ERP with its necessary policy reforms. In the energy sector, many areas in the recovery process fit into AID's Energy Policy framework for assistance. In the management of forest for sustainable forest resources, program activities under NRM provides opportunities to develop projects that will assist GOG's effort in sustainable biomass renewable energy. The NRM project will also help GOG in enforcing its policy on environmental conservation.

The GOG's policy of improving the electricity coverage of the country aims at stimulating rural socio-economic development. This is in harmony with AID's Energy Policy and therefore constitutes a key activity worth AID assistance. This would complement other rural area projects that together would stimulate growth in the rural areas. AID could provide funds for some of the financial gaps or take on some activities as a fundable project.

B. Petroleum and Natural Gas

B.1. Petroleum

The presence of oil in Ghana has been known for nearly a century in the Half Assini area. This presence has been attributed to oil seepage but no successful exploitation has resulted. Known as the Tano Oil Seepages,

it forms part of the onshore portion of the Tano Basin where a total of 17 wells had been drilled between 1900 and 1958. These wells produced minor quantities of petroleum of about 5-7 barrels/day per well. The existence of gas was also indicated.

Ghana's formal production of crude oil started in 1971 at Saltpond about 15km offshore by AGRI-PETCO after the discovery by AMOCO/SIGMAL. The production rate dropped steadily from 5,000 barrels of oil a day in 1977 to 600 barrels per day in 1984. Primary Fuels Inc. then took over but the field was shut-in in 1985 and GNPC took it over.10/ Evaluation of the field made in 1986 on behalf of the GNPC, concluded that the Saltpond field could be developed to produce 8 million cubic feet of gas per day, generating 30 MW of electricity and also 600 bpd of oil for at least six years. The economic evaluation (by GNPC) that followed indicated that the field was marginal and additional reserves need to be proven in the area to lengthen the exploitation life for improved economic viability. GNPC is therefore, currently undertaking further exploration to identify new prospects in the Saltpond field area to be tied to already identified reserves. Meanwhile GNPC is undertaking limited rehabilitation/routine maintenance on the Saltpond Platform and facilities.

The government's aim is to rekindle and accelerate the hydrocarbon exploration so that, once and for all, hydrocarbon potential can be established.10/ Consequently, GNPC is actively pursuing explorations on all prospective sedimentary basins. Some of the basins in exploration are:

Onshore Keta Basin: This is located about 150km east of Accra. Oil exploration started in the basin in 1966 on the lagoon at Atiavi and Anloga where the evidence of the existence of a sedimentary basin was provided. In 1974, a well was drilled at Dzita that showed the existence of gas. After further seismic data acquisition and subsequent drilling of Seville-1 between 1986 and 1987, five drilling prospects were halted as Diamond Shamrock relinquished its exploration interest to GNPC. GNPC took over their onshore drilling rig and other equipment. GNPC has since evaluated all the previous data and has embarked on further explorations and drillings to test and evaluate the oil and gas potential of the area.

Offshore North/Central Tano: This area is located on the Offshore Tano basin in the Western Region about 10-22km from the shore line. Exploration for oil has been going on since 1970. In 1970, the first exploratory well tested oil and gas. In 1980/81, Philips Petroleum Company drilled two exploratory wells and estimated about 135 million barrels of oil in place. The Central Dome which is part of the Tano basin, prospect was evaluated from geophysical and geological surveys by Petro-Canada as more than one billion barrels of oil and over two trillion cubic feet of gas. The current effort by GNPC is intended to consolidate the existing data by carrying out further exploration work to determine the actual extent of the reserves with the ultimate aim of exploitation. Three exploration wells are to be drilled in the Central Dome, North West Tano and the Turbidite basins. It is expected that the results from the three wells will either attract foreign investors or pave the way for GNPC to have access to loans from financial institutions for exploitation.

The South Tano Oil and Gas Appraisal: The South Tano Oil and Gas Field is located offshore, at about 37km from the shoreline, where the water depth is about 100m. It was discovered by a consortium of oil companies in 1978, where four wells drilled on the structure tested for oil and gas. The discoveries were estimated to contain about 147 million barrels of oil and about 850 billion cubic feet of gas in place. Further studies in 1988, however, indicated uncertainties in the field's oil and gas reserves. Currently, studies continue to be made to complete reservoir engineering studies in preparation for development.

Offshore Keta Basin Exploration: This is the Accra-Keta basin for which agreement has been signed for exploration. The oil company has already acquired 2500km of seismic data and has undertaken 700 km of hydrocarbon "sniffer" survey. GNPC is coordinating for a risk exploratory well to be drilled.

Offshore Central Basin (Tema-Takoradi): About 4472 km of exploration survey data was acquired, processed and interpreted. This was followed by another 425km of gravity and magnetic data in the offshore Central Basin to complement the previous data.

Voltaian Basin and Near-Shore/Transitional Zone: The Voltaian Basin which covers about 45% of the country's onshore area has received very little exploration. In 1971, Shell Oil Company acquired airborne magnetic survey data and then in 1975 added 208km recognizance seismic data and in 1977 drilled a shallow exploratory well to a depth of 1157.5m which was dry. GNPC is undertaking a remote sensing study to further explore the oil and gas potential of the area.

The seismic surveys needed for hydrocarbon exploration in the past, have not covered the Near-Shore/Transition zone because of unavailability of the special flat-bottom vessels for such data acquisition. In order to correlate the offshore and onshore as well as a data-base for the near-shore, GNPC is pursuing the acquisition of the near-shore data along the coastal basin of the country.

Since 1963, GHAIP has operated a hydroskimming refinery with a capacity for 1.4million tpy (28,000 bbl/d). This meets the needs of most of the domestic requirements of the country. The refinery's output oscillates between 0.5 million M.T. in 1983 to 1 million M.T. in 1985 which is considerably below operating capacity. Fuel oil accounts for about 25% of refinery output, far in excess of domestic requirements resulting in large volumes to be re-exported at relatively unfavorable prices. The plant has a storage capacity of 0.3 million m3 for products. This is about 70% of capacity utilization but sufficient for present operations.

B.1.1 Petroleum and Natural Gas Supply

Ghana produced a small quantity of petroleum which dropped steadily from 5,000 pbd in 1977 to about 600 bpd in 1984 when exploitation was suspended. All of the country's requirement is presently imported, and in 1985 it amounted to 0.70 million M.T. Oil imports represent a high proportion of the nation's export earnings thus limiting the supply. This was the case in 1984 when petroleum oil imports represented over 40% of the country's export earnings. Offshore deposits of both oil and gas have been identified in the Saltpond, Tano and Cape Three Points. GOC is actively promoting petroleum exploration both onshore and offshore with the aim of evaluating, once and for all, the petroleum availability in Ghana. The natural gas deposit in the off-shore Tano area is roughly estimated at one million cubic feet and studies are on the way to evaluate the gas reserves of the Saltpond field. If these sources prove commercially exploitable, the anticipated use would be for thermal power generation.

B.1.2 Petroleum Consumption

Petroleum consumption has been influenced considerably by its availability. Since the 1970s, various checks were put in place to control consumption. In 1981, the country consumed 0.8 million M.T. of petroleum.15/ This declined to 0.7 million M.T. in 1985 with 10,000 M.T going into gasoil for electricity generation. Consumption also declined sharply, 23% in 1983 and another 4% in 1984, which was mainly due to supply shortages as a result of scarce foreign exchange. The consumption recovered by over 27% when rationing was lifted.

Though the petroleum consumption of Ghana is relatively low by international standards, its import continues to take a significant share of the country's export earnings. In 1985, petroleum imports preempted 26% of the country's non-petroleum export earnings. Thus Ghana's economy is delicately balanced on and fluctuates with the international petroleum market. (Note: The current Gulf Crisis has raised the price of gas/gallon from ¢600 to ¢1600.)

Diesel oil accounts for the largest share (35%) of petroleum consumed, followed by gasoline (34%). Almost half the petroleum consumption is in the transportation sector (49%), while the household and the industrial sectors take up to 31%. Agriculture and industry use 13% and the government/commercial sector consume 6%. (Annex,A-14 shows the consumption pattern for various type of petroleum products.)

B.1.3 Petroleum Prices

Ghana obtained virtually all its crude oil needs over a considerable time from Nigeria for domestic refining. The prices were based on government-to-government contract prices. After refining by GHAIP, the prices are based on ex-refinery prices on which are levied Special Fund (fiscal revenue), Energy Fund (financing energy projects)

and various margins to cover transportation and distribution costs to arrive at the retail price. (See Annex 15 for economic cost and official prices for petroleum products.) Previously, most petroleum products' prices were subsidized. There has been no stabilization fund to compenstate for short-term fluctuations in import prices, nor do retail prices reflect any regional differences in marketing costs. The related margins do not cover costs of deliveries to northern Ghana; a separate fund administered by the marketing firms compensates for that.

During 1983-85, when the cedi went through massive devaluations, the prices of petroleum products went up eightfold. There have been substantial increases since then. The exercise has eliminated subsidies except for kerosene and LPG which the government still subsidizes for social and consumption promotion purposes. Most petroleum prices, therefore, are periodically adjusted to reflect the cedi exchange and the world oil market price. In 1985, the removal of subsidies brought an economic surplus of approximately $ 35 million (US) based on the consumption and exchange rate.

B.1.4 Petroleum Demand

Ghana has a history of petroleum shortages which has been the result of the country's financial difficulties in importing adequate quantities. In addition, distribution problems have caused chronic shortages in some parts of the country. The combined effect has been suppression of demand.

The UNDP/World Bank mission in 1986, made projections of net consumption of petroleum products based on elasticities of demand for different energy consuming sectors. Fuel for electricity generation was based on estimates for future diesel plant use. The petroleum refinery's own consumption and losses are assumed to decline from 9.4% in 1985 to 5% by 1990-95 under the Action-Oriented Scenario but only to 8% under the Trend-based Scenario. Under Action-Oriented Scenario, projection during 1986-95 is relatively moderate rise from its depressed level in 1985 by

6% per annum. A similar projection for Trend-Based Scenario gives 6.5% per annum. The difference in growth would come from energy conservation measures and some efficiency efforts of substitution.

Under the Trend-Based Scenario, final petroleum consumption by 1995 would be about 5% higher than under the Action-Oriented Scenario. However, because of the difference in refining efficiency, crude requirements to meet domestic demand for products under the Trend-Based Scenario by 1995 would be 10% higher, i.e. 1.65 million tpy against 1.5 million tpy under the Action-Oriented Scenario, which would necessitate either a refinery expansion of sizeable products imports. (See Table 6.)

Table 6: PROJECTED PETROLEUM PRODUCTS DEMAND GROWTH AND UNDERLYING ELASTICITIES, 1985-1995 a/

Sector	1986-1990 Petr.Prod. Demand Growth (%)	1986-1990 Elasticity	1991-1995 Petr.Prod. Demand Growth (%)	1991-1995 Elasticity
		Action-Oriented Scenario		
Transport	6.0	(0.87)	5.5	(0.92)
Industry/Mining	9.8	(0.97)	8.9	(1.14)
Agriculture/Fishing	4.5	(0.85)	4.5	(0.90)
Commercial/Gov't	4.0	(1.05)	4.0	(0.82)
Residential	4.8	(1.02)	4.4	(0.98)
		Trend-Based Scenario		
Transport	6.5	(0.94)	5.5	(0.92)
Industry/Mining	10.7	(1.06)	10.0	(1.28)
Agriculture/Fishing	5.4	(1.02)	5.0	(1.00)
Commercial/Government	4.3	(1.13)	4.3	(0.88)
Residential	5.2	(1.11)	5.3	(1.16)

a/ TOE Basis

Source: World Bank Mission estimates.

B.1.5 Constraints on Petroleum Availability

The burden of the petroleum bill has made it imperative for the government to investigate the possibilities for oil finds. However, the required huge capital outlay which the country finds difficult, to put in place, is affecting the pace of exploration.

The total exploration activities are carried out by foreign companies whose interest in exploration is directed by worldwide petroleum prices. Sometimes, the oil glut and low prices have lowered the interest of exploring companies to work in Ghana.

In order to attract exploration companies, the Ghana has to give many incentives or concessions which often are not advantageous for the country.

The GNPC, which is spearheading the exploration drive, does not have adequate human and material resources. Presently it depends, to a large extent, on foreign facilities and expertise. Its institutional strengthening will require considerable resources and time before it will be adequately functional as a full fledge exploration establishment.

Petroleum refining in Ghana, as in other countries, has been marginally viable as a result of refined products being sold at marginal production costs. This leaves inadequate means to amortize investments in new capacity.

The GHAIP refinery has a number of technical and economic constraints: 15/

- deficient maintenance;
- inefficient refinery process design, dating back to the period prior to the oil price increases in the early 1970s;
- excessive refinery fuel use and internal losses estimated at 8% (fuel use of a refinery of this configuration should be no more than 4% and losses should be below 0.2%);
- failure to optimize refining and marketing, in particular, the balancing of output with domestic demand;
- diseconomies of scale (most of today's viable refineries process at least 5 million tpy compared to GHAIP'S 1 million tpy at full capacity utilization);
- refining facility limited to light crude oil processing which is a more expensive alternative;
- GHAIP is not equipped to evaluate on an ongoing basis the options and requirements for optimizing the engineering and economic aspects of refining operations.

Petroleum Marketing:

1. The marketing of petroleum products is plagued with a dilapidated infrastructure which is a result of poor maintenance and repair.

2. Insufficient tank cars for hauling, has been a serious problem because of lack of spare parts and poor state of roads.

3. Incentives for distribution companies to maintain and expand their networks have been slow because the retail prices, profit margins and allocations have been controlled by government.

4. As a result of the absence of differential pricing for petroleum products and transportation difficulties to the northern Ghana, retail outlets are concentrated in the south where about 80% of the products are distributed to the disadvantage of the north.

5. Like most other institutions in the country, the majority of GOIL staff are not exposed to modern techniques and procedures used elsewhere in the industry such as: petroleum marketing, operation and maintenance of facilities, standard safety regulations, environmental protection measures, measurements and accounting practices, and planning capabilities.

B.1.6 Options for Increasing Production and Distribution

Petroleum Exploration:

In order to alleviate Ghana's petroleum bill burden on its development effort, the government should continue to vigorously pursue petroleum exploration in promising basins.

The GNPC, as an executive body for petroleum exploration, is undergoing institute staff training programs to expand expertise in the geological, economic/financial and legal areas related to exploration.

Petroleum Refining:

- The refinery is undergoing a phased rehabilitation program which aims at improving the refinery's energy and general operating efficiency. Funding of this effort is being pursued for an expanded facility.

- If GNPC continues to import crude oil for GHAIP, a strong link between the two companies, with respect to procurement of crude and sale of products in quantity and quality, is needed for optimal refining operations. This is necessary because even small changes in technical specifications may have a significant impact on refining economics.

Petroleum Marketing:

1. Government efforts are being continued towards rehabilitation of existing distribution/storage facilities and increasing the capacity in Kumasi, if rail transportation becomes important in moving petroleum products to northern Ghana. 15/

2. In the face of transportation difficulties and the unprofitability of handling small quantities of products to rural areas, the large distribution companies have been reluctant to reach these areas. Smaller private dealers are now being encouraged to penetrate these areas in order to ensure a regular supply to sustain the development of socio-economic activities in the areas.

3. The Volta Lake offers a safe and inexpensive route for transportation of petroleum products. Efforts should be continued to install jetty facilities along the reach of the lake, in addition to the landing construction in progress at Akosombo and Buipe. The lake transport system would considerably reduce the use of road and rail transport thereby reducing damage to them. The northern part of the country which suffers from the unreliability of supplies would particularly benefit from lake transport.

4. Petroleum product supply to Burkina Faso by the lake could be another attractive market worth investigating. This would boost the petroleum refining capacity and marketing system in Ghana.

5. Training of GOIL staff to handle environmental issues related to petroleum handling should be instituted (eg. disposal of waste products, oil spills, etc.).

B.2. Liquified Petroleum Gas (LPG)

Presently, Ghana obtains LPG as a by-product from petroleum refining. Current exploration has indicated prospective commercial gas finds. The South Tano and the Saltpond Basins are being evaluated for potential commercial natural gas.

NEB is promoting, in urban areas and in public institutions, the use of LPG so that the urban population can reduce its heavy dependence on charcoal. The, otherwise burnt off LPG gas of 6,000 M.T./year at the Tema refinery is being recovered to serve that promotion. NEB has conducted various studies on safety, storage, distribution and appliances. In order to handle the additional 6,000 M.T. a year to be produced from GHAIP. The existing filling plants of GOIL will be rehabilitated and three filling plants in Accra, Takoradi and Kumasi will be installed.

At present, LPG constitutes a small portion of total energy use and it is mainly used as household fuel. With prospective discoveries of hydrocarbons rich in propane and butane, industrial and household use may become important.

In coordination of the government's LPG promotion program, NEB has devised a system which eliminates the direct selling of the cylinders, normally costing ¢15,000 per cylinder, and organized the following supply system (initially in Accra, Tema and Kumasi):

1. Cities are divided into zones to be served by accredited GOIL distributors.

2. Residents of zones get registered for a cylinder after an application.

3. With a telephone call to the local distributor, a filled gas cylinder will be supplied to the home and the empty bottle collected.

4. The "door-to-door" service charge is ¢200 and the cost of gas is ¢100/kg.

5. Marketing fee for the 12.7 or 14.5 kg. cylinder is ¢50 and for 5 or 6 kg. cylinders it is c25. The 2 or 3 kg. cylinders costs ¢10. The system is well patronized and the right impact on gas utilization is expected.

B.2.1 Constraints on Increasing LPG Use

Though LPG is more energy efficient and, in fact, cheaper in the long run, the intial capital investment makes it too expensive for many people. Consequently, only the higher income groups can afford the cost of the cylinders and gas stoves, which generally have no soft payment arrangements. In addition:.

1. The majority of the population considers the use of LPG as dangerous and therefore refrain from its use.

2. The design of gas stoves available is not adapted to local food preparations.

3. As a result of inadequate storage, bottling capacity, insufficient bulk transport vehicles, and the lack of cylinders, supplies of LPG are often irregular discouraging the population from using it.

B.2.2 Options for Increasing the Use of LPG

1. Motivate researchers to devise simple, inexpensive gas stoves adapted to local cooking in order to atttract households to LPG use.

2. Make arrangements similar to that of gas cylinders, permitting progressive payments for gas stoves so that a larger part of the population will have access to them

3. Institute safety education on the use of LPG so that prospective users will be more comfortable with its utilization.

4. Undertake medium to long-term marketing survey of LPG so that domestic consumption and outside market potential can be established to permit adequate planning for plant capacity.

5. Increase supply points or stations which have been limited in the country.

B.3 Petroleum Demand Projection and Future Projects

Petroleum demand in Ghana, since the oil crisis of the 1970s, has been dependent on the availability of foreign exchange. The restriction on the products until 1987 has led to suppressed demand. Table 7 shows the evolution of petroleum production and inland petroleum product deliveries. The average increase during 1986 - 1988 is about 77% when there was active satisfaction of suppressed demand. It is expected that the growth rate will stabilize after 1988 when transportation (taking 49% of the petroleum product consumption) will reach saturation level.

Table 7

Petroleum Production

Year	1985	1986	1987	1988	%Change
Quantity (tons x 1000)	216	200	155	142	-8.4
Import (cedis)					

Petroleum Product Deliveries for Inland Consumption
(Tonne)

Petroleum Product	Year				
	1984	1985	1986	1987	1988
Aviation/Kerosene	1359.6 85737	3717 106455	2995 122598	2448 122218	2695 133568
Gasoline	165478	207737	220598	239124	278546
Auto Gas	188933	227049	243694	259018	271818
Diesel Oil	723	1635	901	1131	3062
Fuel Oil	26787	40090	42019	48823	43947
Total	469825	586661	632805	672762	733636

The government considers efficiency enchancement in the petroleum sector a high priority. Thus, projects are in place to make the Ghana Refinery, active petroleum consuming enterprises and transport sector more fuel efficient and are expected to have an impact on future demand of petroleum products. The extension of hydroelectric power to most parts of the country will result in retiring a number of diesel-based electric power generation as a government policy to cut down on national petroleum demand.

While limiting the demand for petroleum products, the government is also very active in the exploration of hydrocarbon potential to help offset the relatively heavy oil bill. Table 8 shows the projects being undertaken in the Public Investment Program in the petroleum sector under the country's Economic Recovery Program.

PROJECTS REQUIRING FOREIGN FINANCING 1989-93 Table 8

	FOREIGN FINANCING GAP (FFG) US$				
	PROJECT CODE	STATUS	TOTAL	FC	LC
Energy Efficiency Enhancement Programme	NEB 002/88	On-going	0.50	0.50	
Lubricating oils prod. (Lube Blending Project)	MFP 002/88	New	14.77	14.77	
National Electrifica-Scheme	MFP 003/86	On-going	19.98	19.98	
Ministry of Fuel & Power/Ghaip etc.	MFP 004/89	New	13.32	12.2	1
Tema on-shore basin exploration	GNPC 001/86	On-going	2.5	2.5	
Saltpond Oil Field Re-habilitation & Production	GNPC 002/86	On-going	3.0	3.0	
On-shore Keta Basin Exploration	GNPC 003/86	On-going	2.76	2.76	
Off-shore North/Central Tano Exploration	GNPC 004/86	On-going	3.5	3.5	
South Tano Oil & Gas Appraisal	GNPC 005/87	On-going	6.85	6.85	
Saltpond Field Related Exploration Project	GNPC 006/89	On-going	13.82	13.82	
Cape Three Points/ Takoradi off-shore Oil exploration	GNPC 007/88	On-going	8.01	8.01	
Off-shore Central Basin (Tema-Takoradi) Explor.	GNPC 009/89	On-going	7.7	7.7	
Voltaian Basin Remote Sensing	GNPC 010/89	New	0.26	0.26	
Near-shore/Transitional zone survey	GNPC 011/89	New	0.68	0.68	
Refinery Revamping	GHAIP 002/86	New	16.00	16.00	
Secondary Conversion	GHAIP 003/89	New	48.0	48.0	
Development/Logistics Support for GHAIP	GHAIP 004/89	New	1.53	1.53	
Accra 2nd Bulk Supply Point	MFP 005/89	New	5.84	5.42	0

CONCLUSION (SUMMARY REMARKS)

Because petroleum products serve as the life-line in modern economic progress, its supply interruption depressed the socio-economic life of Ghana during various periods of inadequate foreign exchange availability for them. In the ERP GOG is working on all fronts to ensure adequate supply of petroleum products for the country's needs. The exploration and development of hydrocarbon sources are being pursued with active support of the World Bank and participation of private companies and financial institutions. The GNPC is undergoing institutional strengthening to meet the demands of the petroleum search effort. Planned work on the various basins identified in the country have been intermittent because of lack of interest, apparently due to oil glut or low world market price. The higher oil price and demand caused by the current Gulf Crisis is expected to stimulate interest in the Ghana basins.

The twenty six year old GHAIP refinery is undergoing rehabilitation and expansion to improve its refining efficiency and capacity. Distribution of petroleum products have been improved in the recent past and its transportation, using the Volta Lake to the northern part of the country, is being pursued. Petroleum product prices are now determined without subsidies as in the past. Only kerosene and LPG have some subsidies for substitution promotional purposes. The crude price hike of 1990 from $18 (US) to $34 (US) has resulted in about 40% retail price increase in the country. The population is already having difficulties in supporting the new changes. The economic growth rate projected under the ongoing ERP will be reduced. On the other hand, the situation will accelerate the end-use efficiency program for petroleum products under ERP. The retirement of diesel generators of electricity in the electrification expansion is also helping to reduce oil demand.

Since the institution of the formal Public Investment Program in 1986, millions of cedis have been spent on petroleum projects. The 1989-1991 program would require million cedis of which million shortfall is being sought. Substantial progress has been made in the petroleum sub-sector and this is seen in the availability of petroleum products at all times in the country, even, in rural areas which in the recent past suffered from chronic shortages. External assistance is still required to help exploit hydrocarbon deposits if found in economic quantities and arrive at sustainable requirements that can be supported by the country's foreign earnings.

C. Electricity

C.1. Hydroelectricity

C.1.1 Supply

Ghana is said to have hydropower sources, considered technically exploitable, of about 2000 MW derived from the Volta, Pra, Tano, and Oti Rivers. Hydropower supply started in Ghana in 1964 when the Akosombo Dam under the Volta River Project was commissioned. Since then, hydroelectric power has become the main source of electric power supply in the country. This was followed by the Kpong hydroplant which was commissioned in 1982. The two hydropower plants at Akasombo and Kpong have installed capacities of 912 MW and 160 MW respectively. About 40 small potential hydro-sites have been identified with a capacity totaling 20 MW, some of which can be economically supplied to isolated rural locations.

Through a 161 KV interconnection grid, over 1,300 km of hydropower grid has reached most of the large load centers in the south of the country. Togo and Benin have been connected with a 161 KV interconnection since the early 1970s. Since 1983, a 225 KV interconnection transmission with a peak capacity of 100 MW has connected Côte d'Ivoire. (See Annex A-16 for a map of the transmission system.)

C.1.2 Consumption

Though hydroelectricity is inexpensive, only about 15% of the population is said to have access to electricity. The five largest cities accounts for about 75%, of the consumption. Domestic electricity consumption increased at about 5% during 1971-1981, with slower growth during 1977-1981 when economic decline intensified. The peak consumption in 1981 was 1,294 GWh, which represented 109 KWh per capita. This plunged in 1982-1984 during a fall in generation due to drought. In 1985, per capita consumption was 91 KWh, which was below the figure of West African countries of comparable industrialization levels such as Côte d'Ivoire and Senegal (which have 185 KWh and 100 KWh per capita consumption respectively).

VRA electricity sales peaked at 5,181 GWh in 1981. This declined to 1,671 GWh by 1984 as a result of drought problems which forced regulatory cuts.15/ There was a 50% cut in export to Togo/Benin and in domestic supply, and a total suspension of supplies to VALCO. Rationing of hydropower was lifted in 1984 but sales in 1985 were only 57% of their peak in 1981, basically as a result of lower sales to VALCO. VALCO is the largest consumer of hydropower in Ghana accounting for 65% of VRA sales. Less than 10% of sales goes to CEB (Togo/Benin) and Côte d'Ivoire. The rest goes to domestic use.

In 1985, domestic consumers took 1,215 GWh which is about 94% of the 1981 level. Table 9 shows the sectional breakdown of electricity consumption in the country for domestic and export use.

TABLE 9

Electricity Consumption and Exports (1978-1987)

	1978		1979		1980		1981		1982		1983		1984		1985		1986		1987	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
A. DOMESTIC																				
ECG SALES:																				
Residential	342	9	366	8	391	8	437	9	412	9	413	18	316	20	446	16	447	11	469	11
Commercial	192	6	204	5	195	4	188	4	177	4	156	7	165	10	148	5	149	3	156	4
Industrial	466	13	394	9	353	7	364	7	306	7	304	13	232	15	352	13	353	9	370	8
Miscellaneous	18	-	8	-	12	-	16	-	13	-	12	-	10	-	-	-	-	-	-	-
Total	1018	28	972	22	951	19	1006	20	908	20	885	38	723	45	946	34	949	23	995	23
VRA Sales:																				
Mines	250	7	259	6	272	6	274	6	258	5	232	10	219	14	257	10	273	7	234	6
Other	35	1	31	-	25	-	17	-	11	-	11	-	11	-	12	-	28	1	28	1
Total	285	8	290	6	297	6	291	6	269	5	243	10	230	14	269	10	296	8	312	7
Total Domestic	1303	36	1262	28	1248	25	1296	26	1177	25	1128	48	953	59	1215	44	1245	31	1307	30
B. EXPORTS (VRA)																				
VALCO	2086	58	2906	65	3319	67	3303	65	3009	64	753	32	13	1	853	31	2125	52	2475	58
CEB	217	6	299	7	440	8	472	9	521	11	491	20	317	20	447	16	486	11	410	10
EECI	-	-	-	-	-	-	-	-	-	-	-	-	311	20	237	9	237	6	99	2
Total Exports	2303	64	3207	72	3759	75	3775	74	3530	75	1244	52	641	41	1537	56	2798	69	2964	70
Total Sales	3606	100	4469	100	5007	100	5071	100	4707	100	2372	100	1594	100	2752	100	4043	100	4291	100

C.1.4 Hydroelectricity Prices

After studies (conducted by Coopers and Lybrand, UK, on behalf of the Ghana Government) which aimed at development of tariffs that reflect the economic cost of supply, affordability, generation of sufficient revenue to ensure financial viability and easy administration, the government agreed to adopt a uniform national tariff structure, based on long-run marginal cost of supply.

Two types of bulk tariffs are applied to the VRA power supply in the grid system:

1. Those of VRA for bulk domestic customers - ECG, Akosombo township, textile factories and mining enterprises, foreign customers (VALCO, CEB of Togo/Benin, and EECI of Côte d'Ivoire).

2. ECG's retail tariffs for its domestic customers.

Both groups of tariffs include demand and energy charges for industrial and commercial consumers. Residential consumers bear energy charges only. The electricity tariff for bulk supply to ECG, VALCO and for export are negotiated periodically.

VRA's domestic consumers were subjected to price increases during the period 1985-1986 that raised the demand charge by 300% and the energy charge by 1 500%. Tariffs for foreign consumers during the same period were raised about 350% to give about US 4 cents/KWh for CEB and EECI. 3/ The charge to VALCO went from (US)0.5¢ to (US)1¢/KWh as part of renegotiation of the tariff which would change with electricity supplies and the international price of aluminum. Another VRA increase was in April 1986 which varied between 30% and 65% depending on the tariffs. ECG increased their tariffs from 1983-1986 by 650% on the average. Most of the increases were effected in 1983 and thereafter it was limited to about 5% every three months until the end of 1985. In April 1986, another ECG tariff increase averaged at 60%. Despite recent increases, the electricity tariff in Ghana is still low compared to other countries in the region, even countries having hydro-based systems. Ghana's low tariffs are mainly the reflection of the relatively low cost and efficiency of the country's hydro-power system. (See Table 10 for tariff schedule structure and rates for 1988.)

Table 10

GHANA

ELECTRICITY CORPORATION OF GHANA

Tariff Schedule
Structure and Rates for 1988

TARIFF CATEGORY	---- MONTHLY RATE ---- (CEDIS)	
High Voltage Supply	Maximum Demand	464/kVA
(415 volt and above)	Energy	4.38/kWh
	Service charge	1340
Low Voltage Supply	Maximum Demand	516/kVA
(Below 415 volt)	Energy	4.88/kWh
	Service charge	1340
Non-Residential	Energy	14.0 kWh
	Service charge	100
Residential (kWh/month)		
0 - 50	Block charge	255
51 - 200	Energy	3.9/kWh
201 - 600	Energy	5.8/kWh
601 and above	Energy	13.4/kWh

1% of Public Lighting Levy to be applied to all electricity bills of Ghanaian customers.

C.1.5 Broad Constraints to the Hydropower System

As a result of the past decline in the country's economy, ECG has been particularly hard hit. This resulted in service deterioration with a high incidence of power failures stemming from breakdowns in the distribution network. The backlog of rehabilitation work is enormous with its financial requirements of huge foreign exchange costs.

ECG has suffered from ineffective management, organizational and staffing problems. The results are uneconomical operation and inadequate maintenance. The corporation's financial deterioration has been caused by inadequate cost control and insufficient tariffs in the past. This has been aggravated by deficiencies in billings and collection. The Corporation's technical and administrative losses are high (15% in 1986).

Though there is abundant inexpensive hydropower in the country, adequate coverage necessary for many modern sector activities has been low. The slow extension of the distribution system left the country with electricity being only 3.4% of overall energy use and only 13% of commercial energy use in 1986. The rural area coverage is only 4%. The low coverage has affected the volume of the corporation's business for profitability.

The most disturbing constraint to the hydropower system is low reservoir level during severe drought. This, as was unexpectedly experienced in 1983-84, is a continuing threat to reliability of the system's supply.

ECG has been experiencing difficulties in recruiting and retaining suitable, qualified staff because of unattractive employment conditions and understaffing in the professional and managerial positions but overstaffing at the semi-skilled and unskilled levels. There is a shortage of trained personnel at all levels. This has lowered the expected output of the corporation.

The unreliability of the system, mainly due to outages, has discouraged many households from shifting to electric stoves, which are being encouraged in the country to reduce the pressure on woodfuel supply.

C.1.6 Options for Increased Hydropower Use

As quality and efficiency of the hydroelectricity supply depend on the skill of operation, the VRA and ECG should continue strengthening their organizations by offering suitable training for the staff.

The government should continue to search for funding for forging ahead with the necessary rehabilitations so as to improve the reliability of the systems for external marketability.

In light of the effect of drought on hydro-dependent electricity supply to the country, the VRA should continue its efforts in the rehabilitation of the thermal plant in Tema and the development of thermal sources for improved security of electricity supply.

C.2 Thermal Power Generation

C.2.1 Supply

The source of power until the mid-1960s was through diesel generating sets. In 1987, thermal generation capacity was 58 MW. Nineteen isolated load centers, varying in size from 118 KV to 30MW, provide about 58 MW among which the Tema plant providing 23 MW plant constitutes the largest. The diesel plants are generally old, badly maintained and often lacked fuel and spare parts. Most of these centers do not have 24-hours supply and there is a high level, of suppressed demand. Prominent among self-producers of thermal power are the sawmills. The total captive generation capacity is estimated at 30 MW, of which 23 MW is used in the mining and timber industries, hospitals, Water and Sewerage Corporation, schools, and some commercial enterprises. With the exception of Min Timber Company and other sawmills, it is mainly used for stand-by purposes in the event of power failure. A number of the small stations would be retired under the Northern Grid Extension Project and other IDA-proposed projects (See Annex A-17 for existing generation facilities).

C.2.2 Consumption

With cheap hydropower available and the problem of petroleum bill burden on the country, there has been a general move to tap into the hydropower grid where it is available. The Northern Grid Extension Project, which reached Bolgatanga in April 1990, and the active rural electrification in progress, have been replacing existing thermal diesel-based generation of electricity. In 1985, the diesel oil consumption for electricity generation was estimated at 10,000 M.T. Before the grid extension to Brong Ahafo and northern Ghana, only about 20,000 connections (ECG customers) were in the isolated load centers north of Kumasi. In general, the consumption of diesel-based electricity is being discouraged and is expected to be drastically reduced when the rehabilitations and the major grid extentions in progress are completed. Cost and procurement problems of diesel oil have also contributed to its low demand.

C.2.2 Prices of Diesel-Generated Electricity

Though the price of diesel-generated electricity is about (US)15 ¢/KWh, ECG charges a uniform rate as for the hydroelectric grid at an average of ¢5.8/kwh. Therefore, when possible individual generation by diesel is being avoided. Timber firms have been relocating their milling operations near the hydroelectrical grid even when they have to bring logs over long distances to the mills.

C.2.3 Constraints on Diesel-Based Electricity Production

The petroleum bill strain on the foreign exchange earnings of Ghana makes diesel-based electricity generation an undesirable source of commercial energy.

ECG charges far less for its centers using diesel-based generation than the actual economic cost, thus making the generation uneconomical.

Lack of adequate maintenance, regularity of fuel supply, transportation problems due to poor roads and lack of spare parts make the diesel-based system an unreliable source of commercial energy supply.

The financial constraint on the country is the main obstacle to the evaluation and eventual exploitation of natural gas for thermal electricity generation.

C.2.4 Option for Use of Diesel-Based Electricity Production

Diesel-based generation of electricity should be used as electric power only when there is no other possibility, and in other cases it should only be used as a standby or back-up. Other means of generating electricitiy using renewable energy should be pursued

The government should actively pursue the evaluation and development of gas finds for thermal generation as a security measure against a prolonged drought effect on hydro-electricity generation.

C.3 RURAL ELECTRIFICATION SCHEME

In Ghana, as in many places, electricity availability is a cherished hope for the population in order to access modern economic and social life. Lack of it is looked upon as a key element responsible for rural exodus to urban centers. The rural exodus in Ghana has contributed to the high rate of urban population growth estimated at over 5%. The consequence of this in the urban areas is the pressure on the invariably inadequate urban infrastructures of housing, transportation and health. Another consequence is unemployment. Politically and morally, it is compelling that power should be provided to the rural areas to stimulate productivity in existing rural activities. Electrical power wil also encourage the introduction of other local industries that will enhance economic development. This will improve the quality of life and will help stem the exodus tendency.

An inter-ministerial Rural Electrification Committee under the chairmanship of the Ministry of Fuel and Power advises the government on the program. Priority has been given to supplying electricity to

district capitals, followed by townships of economic importance and those within 20km service range of grid substations in existing electricity networks. The initial GOG aim is to supply 20 rural centers per year but this has run into problems with irregular funding.

Despite the abundant electricity resources in Ghana, only 15% of the population has access to electricity including 4% of the rural population. Current rehabilitation, extension and expansion programs in the power sector are instituted to address the unsatisfactory coverage. As more reliable and cheaper electricity reaches rural areas, it is expected to stimulate and promote growth of rural industries, improve standards of living and serve key social institutions like schools, hospitals etc., and power tubewells for domestic and irrigation water supply.

In line with GOG's 30-year coverage plan for the whole country, the Fifth Power Project will undertake a comprehensive study of electricity requirements for each region and associated investment needs, ways of complementing or strengthening existing ECG/VRA systems to handle the proposed load and coordination of all ECG/VRA activities. This would result in a National Electrification Master Plan. 10/ The major component of the plan is:

National Electrification Planning Study. This would develop a National Electrification Master Plan from which prioritized and phased electrification programs would be selected for implementation. The two components of the study are:

- Regional Electrification Studies: This would cover all regions that do not have comprehensive electrification programs; and

- National Electrification Study: This will coordinate all Regional Electrification Studies into a workable National Electrification Master Plan, properly phased out to be implemented over the next 30 years.

C.3.1 Assistance Interventions

While the National Electrification Master Plan is being prepared, GOG is implementing electrification projects scattered throughout the country with assistance of donors. During 1986-92, the following projects are being undertaken: 10/

a. Electrification Projects under Indian Credit Line: This project supplies power to towns and villages within 20km of the existing 33kv/11 kv lines in order to open them up and encourage cottage industries. Population size and economic potential are priority consideration for hookup. Communities which contribute labor and purchase local materials, including poles, would then benefit from the credit which would cover the imported materials needed. Some 150 towns/villages in the southern part of the country are earmarked to benefit from the project. (See Annex A-18 for the breakdown of places to benefit from the credit.)

b. Extension of Electricity Grid Under Japanese Grant: This will finance three projects in the Ashanti, Western and Central Regions made up of:

   - extension of 30 km of 33 kv line from Kumasi to Bekwai with towns and villages along the line, and also to Lake Districts to provide power for fishing communities;

   - extension of 20 km of 33 kv line from Daboasi to Komenda; and

   - extension 50 km of 33 kv from Tokuse through Kasewa to Senya Breku, Bodwiase and Mankrang junction to link up with Kwanyako to supply farming communities and large scale commercial farms.

c. Electrification of Western Regions: This will involve widescale electrification of the region with assistance from the Yugoslavian government.

d. Completion of Volta Region Electrification Phase I: Phase I, financed with the assistance from KFW, would be completed and Phase II preparation would begin. The phase 1 involves hookup of the regional capital, Ho, to the national grid and extension to urban population areas north of Ho.

e. Electrification of Central/Eastern Region: The Swedish Agency for International Technical and Economic Co-operation and GDR(now part of United Germany) government have expressed interest in funding the electrification of the Eastern and Central Regions respectively. The details of cost, conditions, effective dates would be negotiated after the regional electrification studies have been completed and projects identified in the regions.

f. Electricity Supply for District Capitals: This would involve serving district capitals not currently served by grid extension or diesel generators.

Work Program for 1989-91: (The table in Annex A-10 depicts the investment schedule and financial plan for 1989-91).

As part of the ordered steps relative to the electrification of the country, the GOG's policy on rural electrification over the next 3 years has been directed towards the following areas in order of priority:

- electrification of all district capitals;
- completion of all ongoing commnunal self-help electrification projects;
- extensions of electricity supply to all towns and villages within 20km of existing grid supply network.

The GOG has completed studies for the electrification of 27 district capitals which are without electricity supply and have not been designated in any immediate electrification programs either under the current VRA/NED or ECG electrification projects. Of the 27 district capitals which require electrification, 14 are located in the ECG supply area and 13 in the VRA/NED supply area. (The identified district capitals are listed in Annex A-20 and the summary of cost estimates by region is provided in Annex A-21).

In the GOG's decentralization policy, the district capital has become the economic and political nucleus of the rural area groupings. Development will extend from the district capital to outlying rural areas. (The cost of the complementary assistance sought over the next three years for the district capitals is detailed in Annex A-22.) GOG has left the choice of district capitals for funding to the donor agencies.

C.3.2 Implementation Agencies for National Electrification Scheme

VRA plays its traditional role in the (161 kv, 69 kv) power transmission to the designated areas of the National Electrification Plan. ECG then continues with the transmission and the eventual distribution to serve the selected towns/villages. ECG will maintain implementation of the ongoing rural electrification program in the southern part of the country. With corporate reorganization, ECG is expected to manage the future national electrification projects and the satisfying improvement in performance efficiently.

VRA has surveyed the ECG installations in the Northern Grid Extension Project (NOGREX) project area. VRA has prepared proposals for the Kuwait Fund for Development (before the Gulf Crisis) for financing needed investment to maintain an efficient distribution system. It has also established a department for the management of the new distribution responsibility. Known for efficiency, VRA is expected to satisfactorily implement all future national electrification projects in the northern part of the country.

C.3.3 Constraints to Rural Electrification

In Ghana, the main constraints to extending cheap hydropower to the rural areas are:

1. Funding difficulties of the GOG to keep satisfactory rate of power extension to offset the country's low coverage.

2. Inability of rural population to meet the economical tariffs based on the long run marginal cost of the electricity supply which is a GOG pricing policy. This has become an obstacle to revenue collection.

3. Unavailability of complementary infrastructures that together with cheap hydroelectricity will promote perceived economic growth.

4. Inadequate local maintenance management of the distribution system.

5. Inability of some rural populations to raise the initial input conditional to benefiting from certain GOG and donor extension projects.

6. Dependence on imported inputs like transmission lines, supports and accessories with their rising prices and availability problems.

C.3.4 OPTIONS FOR IMPROVING RURAL ELECTRIFICATION

To effect the scheme, GOG has pursued the following steps:

- GOG has prepared fundable projects and has multiplied its solicitation efforts for funding to accelerate coverage of the country.

- Coordination between regional and district planning authorities is being encouraged in order to put in place complementary infrastructures that would maximize electricity benefit to the localities.

- GOG is encouraging private ventures into the manufacture of electrical materials in order to bring to the rural population affordable and readily available materials to help them patronize the new electricity facility.

C.4 Demand Projection and Future Projects

Electricity sales of 1981 of 1296 Gwh by ECG went down to a low of 953 Gwh in 1984. Improvements in the sector under the Economic Recovery Program, have reversed the descending sales trend and in 1987 it recovered with the sales of 995 Gwh, a 5% over the 1986 sales. In 1988 the sales were over 1097 Gwh over 10% with respect to 1987. (See Table 11 for 1987-88 sales.) The demand forecast by ECG consultants estimate that the electrical energy demand will grow at 4.7% per year during the 1987-1997 period. But due to the backlog of suppressed demand, the growth in the first period will be more than 5%.

ECG Electricity Sales for 1978 - 1988

Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Sales (Gwh)	1018	972	961	1006	908	885	723	946	949	995	1097
Percentage Change	-	-4.5	-1.1	4.7	-9.7	-2.5	-18.3	30.8	0.3	4.9	10.3

The power demand projection for the country in the World Bank report of the Fifth Power Project is shown in Table 12. The recent system planning studies indicate that there will be a need for additional power source to meet demand from 1990, if the the current supply committments will be maintained, (i.e. supply to VALCO and exports to Togo/Benin and national coverage). This is based on a future firm hydroelectric supply of 4,880 Gwh and a maximum guarantee supply to VALCO of 2760 Gwh.

Power Demand Projection

Table 12

	Actual	Forecast							
	1987	1988	1989	1990	1991	1992	1993	1994	1995
DEMAND (GWh)									
Ghana: ECG	1265	1318	1350	1385	1405	1426	1480	1555	1632
NED				71	95	125	151	168	186
Others	312	335	380	393	414	435	476	498	498
Subtotal	1577	1653	1730	1849	1914	1986	2107	2221	2316
Export: CEB	410	301	330	360	390	420	450	450	450
VALCO	2475	2745	2760	2760	2760	2760	2760	2760	2760
Cote d Ivoire	99								
Subtotal	2984	3046	3090	3120	3150	3180	3210	3210	3210
Total Demand (GWh)	4561	4699	4820	4969	5064	5166	5317	5431	5526
SUPPLY									
Firm Hydroelectric	4557	4695	4816	4800	4800	4800	4800	4800	4800
Diesel incl. Tema	4	4	4	4	1	100	100	100	100
Deficit				165	263	266	417	531	626
Total Supply (GWh)	4561	4699	4820	4969	5064	5166	5317	5431	5526

The government has embarked on a number of projects that are the continuation of rehabilitation/reinforcement of the existing system and investment in additional generating facilities. This includes the Fifth Power Project for ECG to continue the sector policy reforms started in the previous Power Rehabilitation Project. It is to help establish ECG as a commerically oriented entity, capable of delivering a reliable and economic supply of electricity to its customers. The Fifth Power Project also assists GOG in developing a compressive sector development strategy and long-term electrification program. Other projects include the construction of a new gas-based thermal generating station of 200 MW to help meet the projected supply demand arrived at from the studies of Acres International Limited, the consultant to VRA. The thermal system is preferred, as an expansion to the hydro generating system, to serve as a complementary source in time of drought. See Table 13 for the list of ongoing projects in the GOG's Public Investment Program. One of the constraints to timely completion of these vital projects is the availability of required funding.

TABLE 13

Project	Estimated Completion Year	Planned Expenditure Foreign Cost	Local Cost
VOLTA RIVER AUTHORITY			
Northern Electrifiction & System Reinforcement	1991	20884	2844
Power System Rehabilitation Phase II		4129	173
Rehabilitation of Tema Diesel Plant		1994	217
Technical Assistance/Training Centre for VRA		4493	1082
Anti-Corrosive Painting of Akosombo Plant		496	49
New Thermal Generating Station (200 MW)	1992	20907	5675
Akosombo Generation Station Rehabilitation		16466	3987
ELECTRICITY CORPORATION OF GHANA			
Rehabilitation/Improvement of ECG Distribution System	1992	12255	2075
Development of 33 KV Sub-Transmission System		2465	593
ECG System Expansion Programmes		4727	1137
ECG District Centres Rehabilitation (System Expansion Programmes)		828	199
Extension of Distribution Network to Diesel Fed Locations		1619	390
Installation of a Supervisory Control & Data Acquisition (SCADA) System for Accra& Tema		828	195
Institutional Strengthening of ECG		9596	1869

C.5 CONCLUSION (SUMMARY REMARKS)

The hydroelectric system capacity of 6055 Gwh per annum is a valuable asset to Ghana. It is permitting export and serving heavy industries as well as satisfying other domestic uses. Though generation, transmission and distribution have suffered deteriorations in the past, rehabilitation and expansions of the systems under the ERP have made enormous progress. The electrification of the whole country planned within the next thirty years is being implemented, starting with the district capitals. This electrification of the country is essential for the socio-economic development of the rural areas. Financial assistance from donors is being sought and the setting is an appropriate area in line with AID Energy Policy for possible funding assistance.

The ECG has improved through the institutional building contract with ESB ECG has started exceeding targets set in the corporate contracts with the government. ECG and VRA are on track to become viable commercial establishments.

Electricity prices have been undergoing periodic increases in order that the power establishments can make reasonable profits for investment. However, with reevaluated assets in the electricity sub-sector tariffs to meet the long run marginal cost of electricity, differential tariff structure is used. This has helped to keep the household tariff affordable while the other users pay more.

D. Solar Energy

D.1. Supply and Consumption

The oil crisis of the 1970s and the early 1980s rekindled solar research and placed solar energy as the world's hope for future renewable energy. In Ghana, the large pre-emption of the oil bill on the country's foreign earnings, the drought of 1983-1984 that demonstrated the vulnerability of the hydro-based energy system and the over-dependence on these sources clearly signaled the need to tap into more indigenous renewable energy sources. Solar research, technology and installations have became a viable alternative. The GOG is therefore pursuing the development of solar power as an alternative and complementary energy source.

As a tropical country, Ghana enjoys substantial solar energy. It has an annual average sunshine duration between 1945 and 2724 hours and mean daily solar radiation of 16-20 MJ m^2. Traditionally, solar energy is used for drying agricultural produce and domestic washings.

The NEB has located, to date, about 300 solar equipment installations owned by over 13 organizations and institutions. The installations are photovoltaic-powered systems which have been in use since 1983. Most of the installations are used for communication and they belong to the Post and Communication Corporation, the Ghana Cocoa Board and the Railways Corporation. This is followed by refrigeration installations which are owned by the Ministry of Health for preservation of laboratory specimens, storage and preservation of vaccines. The rest is for water pumping and lighting.

D.2. Current Activities in Solar Energy Research

Various research institutions in Ghana have been studying solar photovoltaic-based electrical energy and solar thermal energy particularly after the 1973 oil crisis. 8/ All these research efforts were conceived to address specific development problems where indigenous renewable energy could not be used for solving those socio-economic development problems in the country. Between 1987 and 1988, NEB carried out a study to identify and review energy research and development in order to examine the options for new directions and approaches for future research efforts. The results of these studies have led to a coordination of research efforts with a systematic approach.

Currently, NEB is involved in the following activities: 9/

- monitoring and evaluation of the performance of solar photovoltaic systems in Ghana;
- evaluating solar and wind energy resources in Ghana;
- demonstration of integrated solar power for villages; and
- conducting a feasibility study on substitution of solar energy for oil in large scale commercial crop drying.

The evaluation of solar resources activity has, in 1990, culminated in a "Data Information and Solar Radiation Map of Ghana" to be produced by the NEB and Meteorological Services Department before the end of 1990. NEB is also in position to release publications and brochures and hold a series of workshops for local agents for solar systems to enable them to import appropriate systems to the country. Ten sizes of the solar systems have been identified for their adaptibility that make them function efficiently under the weather conditions of the country.

Thus with maps and designs, local agents of the solar energy equipment supply would be able to size and design the appropriate systems. NEB requests that those intending to install a system contact the Board before the installation. If needed, the Board would assist them. These steps are necessary because the over-sized systems break down most of the controllers due to the fact that the energy they produce becomes more than required while the under-sized ones produce less energy than

required. NEB experts have also been repairing installations which have ceased to function (e.g., they have helped the Ministry of Health restore 30 solar- powered refrigerators which were nonfunctional because of incorrect solar radiation data).

The NEB is compiling a list of experts available in the country to constitute an advisory source for individuals and organizations intending to invest in photovoltaic technology in the country. (Table 14 gives the inventory of ongoing solar energy research in Ghana.)

E. Wind Energy

Harnessing wind energy in Ghana, has not yet been developed. The general impression is that wind characteristics are moderate in Ghana, with 1.5 - 2.8 m/s recorded up to date; they are insufficient for energy purposes based on existing technology. 9/ But recent observation visits by NEB staff have shown that because the collection and compilation of wind data has been beset with a number of problems, the reliability of the information collected is in doubt. Some of the instruments were found to be installed incorrectly and others were not calibrated for several years. Further, economic difficulties of the past decade have not allowed for the replacement of broken instruments. Compiled data has not been in the form and quantity suitable for design and evaluation of wind technology for specific applications.

In the quest to identify the potential of all renewable energy sources, NEB is reviewing the Ghana Meteorological Services data for the past ten years and installing additional measuring instruments. Study will enable NEB to select sites of high windspeeds for applications of wind energy technology.

5. ENERGY RESEARCH

Ghana, like other developing countries, depends heavily on woodfuel for most of its energy needs. Petroleum products constituted 23% of the national energy consumption in 1985. But the petroleum bill has been strangling the development budget of the country. In 1981, petroleum products constituted 40% of the national foreign exchange earnings. The oil crises of 1973, early 1982 and the one of 1990, due to the Gulf crisis, have destabilized the fragile economy. The declining values of the country's major export commodities also make it more difficult to manage the socio-economic problems. The problem in Ghana is compounded by the depletion of woodfuel, the dominant energy source, in some parts of the country and around major urban centers. Further, the hydro-based commercial energy supply is vulnerable to the effects of drought.

Table 14

INVENTORY OF ON-GOING ENERGY RESEARCH IN GHANA

HARDWARE ORIENTED

ENERGY SOURCE	END-USE/PRODUCT	CONVERSION DEVICE	INSTITUTION	STATUS	REMARKS
1. SOLAR ENERGY	(a) Domestic/Commercial hot water	(i) Single-glazed flat plate, thermosiphon heater.	Mech. Eng./UST	Lab. Prototypes	Active
			Physics/Legon	"	Active
			Agric Eng./UST	"	Active
	(b) Industrial hot water	(i) Double-glazed flat plate, thermosiphon heater	Mech. Eng./UST	Lab Prototypes	Initiated in 1988, Active.
			Agric Eng/UST	"	
		(ii) Linear parabolic concentrator	Mech. Eng./UST	Prototype	Started in 1985, still active.
	(c) Crop drying	(i) Natural convection cabinet dryers	Mech. Eng./UST	Prototype	Active
			Physics Dept/UG	"	"
			Home Science/UG	"	"
			FRI/CSIR	"	
			Agric. Eng./UST	"	
			DRHCI		Planned
		(ii) Natural convection, flow-thru dryer	Mech. Eng./UST	Prototype	
			Home Science/UG	"	
			FRI/CSIR	"	
			Agric Eng./UST	"	
			Physics Dept/Legon	"	
			Nutrition & Food Science/UG	"	
		(iii) Forced convection dryers	Mech. Eng./UST	Prototype	Active
			Agric. Eng./UST		

The obvious response to this crisis for petroleum importing countries and particularly the developing ones is intense research to obtain alternate sources, if possible, indigenous sustainable sources. The GOG has, in the Economic Recovery Program, placed a heavy responsibility on the policy makers and Ghanaian researchers to plan and develop sustainable energy resources for the future.

Under the coordination efforts of NEB, a lot of work has been accomplished in establishing a coherent framework and programs for future directions and priorities for energy research.

Table 15 indicates the status of the indigenous technology development effort in Ghana. (Annex A-23 also lists the new technologies in the energy sector.)

5.1. Constraints to Indigenous Research and Technology Development 21/

1. There are certain missing links in the indigenous technology cycle which make it difficult for research products to reach the commercialization stage; some of these are:

   - inadequate designs of prototypes and need for improvement in materials used;

   - difficulty of local manufacture owing to inadequate manufacturing capabilities and non-availability of requisite materials;

   - lack of engineering designs of various components of the end products.

2. Lack of coordination has brought about some duplication of research effort.

3. Some of the indigenous research work has been directed to academic achievement recognition rather than attempting to meet the needs of a target group.

4. Some of the research work does not conform to any national order of priority which might have been evolved by decision-makers in the energy sector.

5. There has not been any evaluation criteria for assessing the technical and commercial viability of the research outputs.

6. Renumeration and rewards for the researchers have not been attractive enough and have led to a lack of motivation. Equally, there is a lack of adequate funding to support viable research work.

Table 15

STATUS OF INDIGENOUS TECHNOLOGY DEVELOPMENT EFFORTS

BASIC RESEARCH	APPLIED RESEARCH	PILOT TESTING AND DEMONSTRATION	EVALUATION	COMMERCIAL AVAILABILITY	COMMERCIAL AVAILABILITY BASED ON IMPORTED SOURCES
PLANT RESEARCH		SOLAR THERMAL	BIO-GAS	SAW DUST STOVES	SAW DUST BRIQUETTING
SOLAR PV MATERIALS	CROP RESIDUES	FUELWOOD STOVES	CHARCOAL MAKING	CHARCOAL STOVES	SOLAR PV SYSTEMS
	WOODGAS	PYROLYSIS	- CASSMANCE -BRICK KILN	CHARCOAL MAKING	SOLAR WATER HEATER
	GASOHOL	ENERGY CROPPING		FISH SMOKING	
	VEGETABLE OIL	(UPPER EAST REGION IRRIGATION AND GLOBAL 2000 PROJECT)		(CHORKOR SMOKERS)	ELECTRICAL COKKING STOVES/REFRIGERATORS
					KEROSENE COOKING STOVES
					PALM OIL BASED POWER GENERATION

5.2. Improving Research in the Energy Sector 21/

Various reviews of past, present and future energy research in Ghana have been made by several groups and institutions. 8/ Emphasis has been laid on these recommendations for an effective national research drive:

1. Strengthen institutional links between all energy organizations with NEB playing the central coordinating role.

2. Facililitate the adaptation process of both imported and indigenous technologies by:

   - developing industries for the manufacture of technology,
   - encouraging large energy institutions to support research that conform with their institutional objectives,
   - increasing local skills level to conform with imported technologies,
   - establishing evaluation criteria that would rank indigenous technologies for promotion,
   - using the Technology Transfer Center to support commercialization of technologies,
     giving incentives to end users and entrepreneurs who are producing indegeneous technologies for commercial use
     using NEB to coordinate research activities to avoid duplication,
   - maintaining a comprehensive and current data base which would be available to the research community and industry.

3. In addition to setting priorities in the energy sector, NEB should develop a long term plan for the sector (20-25 years).

4. Energy sector projects should be integrated into the overall regional economic development program. NEB should, therefore, establish a relationship with the decentralized Regional Administration system for dissemination of information so that NEB works programs that are relevant to their needs are incorporated into their economic development programs.

5. The government should strengthen human resource capabilities in energy research through training and motivation programs. Financial or national awards for successful commercialization of indigenous developed technologies would help.

6. EFFICIENCY OF ENERGY END-USE

In addition to conducting search for more energy and its alternatives in order to assure future needs at manageable costs, Ghana can also increase energy efficiency. This can be done by lowering cost and reducing supply need. Relatively low prices of energy have caused little awareness of the need to save energy. Only a few large firms have been making efforts to

save energy. In restructuring the energy sector, GOG, has begun to work on the problem and instituted an energy conservation office at VRA with CIDA assistance. (The NEB has also developed programs to pursue energy conservation).

6.1. Household Sector

Because the greatest share of the national energy consumption is the household sector, improving its energy efficiency would contribute appreciably to the overall energy economy. The household energy end-use efficiency is low. Improved stoves and more effective cooking techniques are the principal means for improving the energy efficiency in the household sector. It is estimated that the use of efficient charcoal burning stoves would reduce the fuel requirement about 20%. 9/ It has also been established that charcoal is one of the most expensive energy forms in Ghana on a per unit delivered energy basis. This is creating a substantial financial burden for the poorest sections of the urban population who rely exclusively on it. NEB, in collaboration with financial institutions and the universities, is implementing a project which will introduce and popularize more efficient charcoal stoves. This is being done in the 2/ country by:

- investigation of the socio-economic, financial and cultural parameters in the use of charcoal stoves;
- research and development (including field tests) of prototypes;
- training of stove producers;
- monitoring and evaluation of stoves bought after field testing;
- implementation of a publicity campaign; and
- dissemination of the accepted stoves in all major urban areas.

Another option for enhancing household cooking fuel efficiency is substituting kerosene and LPG for woodfuel. Because of the attractiveness of LPG, both in cost and convenience, NEB has undertaken a dissemination project for increased usage. This step has reduced the capital investment of ¢50,000 to ¢5,000 for LPG users. It is expected to reduce the amount of wood cut for charcoal (3.6 million tons). See Table.16 (below)for comparative cost of LPG and charcoal in Accra:

Table 16

Comparison of LPG and Charcoal Costs in Accra.

Fuel	Energy equivalent	Unit Cost ¢	Total Cost ¢
LPG	15kg	100/kg	1,500
Charcoal	2.5 bags	1,600/bag	4,000

A cheap combined charcoal/LPG combination cooker, developed through the the coordinating effort of NEB, is planned to be on the market before the end of 1990.

6.2. Electricity Use for Air Conditioning and Water Heating

The Electricity Conservation Office of the VRA is undertaking the necessary steps to ensure efficiency in air conditioning.

Electricity used for air conditioning can be reduced in the country by: 15/

- improving operation and maintenance of the units;
- introducing more efficient units with appropriate control devices; and
- reducing air conditioning requirements of new buildings through proper architectural design which can be introduced without raising construction costs.

Units designed for temperate climates use may be 30% less efficient in Ghana because of the higher ambient temperature. The power requirement by the modern units can be up to 40% less than of the old ones.

Electricity use for water heating in residence, commercial establishments and public buildings can be replaced by solar heaters. The use of solar energy for heating water is particularly favorable in Ghana because of the high solar radiation and ambient temperature that prevail. A government directive or law for its use, at least in public buildings, would go a long way in popularizing solar heaters. NEB has established radiation-base data for different parts of the country to use in the installation of solar equipment including water heaters.

6.3. Industrial Sector

The energy consumption of the industrial sector is estimated at 100,000 tpy of petroleum products and 550 GWH of electricity. This was approximately 20% of the country's commercial energy consumption in 1985. Because the relatively large and diversified industrial capacity is underutilized and dilapidated, there is depressed efficiency of energy utilization. A lot of the equipment has been acquired second-hand without due consideration for minimizing energy cost. Deterioration state of some equipment with respect to energy is such that in some cases complete replacement is necessary . Further, inadequate skills and practices of plant operators adversely affect energy efficiency in the industries.

Due to severe fuel and electricity shortages in the recent past and their increasing cost, energy conservation measures have surfaced. GOG, through the NEB, has started programs to enhance energy efficiency in the industrial sector. Sixty Ghanaian professionals have been trained in industrial energy conservation and energy auditing techniques. These professionals are serving as consultants to the industries. The industrial establishments have become enthusiastic about the audits because of the substantial savings being achieved at relatively small investment cost. Surveys have also been carried out on industrial energy consumption, end-use patterns and assessment of potential savings in selected industrial firms. UNDP has funded training experts and energy measuring instruments.

6.4. Transport Sector

Road transport consumed about 238,000 M.T of fuel in 1985, making up 80% of gas oil and almost 100% of gasoline produced in the country. Fuel saving programs are, therefore, important in the sector. 15/ Fuel efficiency is rather low in the sector because of overaged vehicles, technically inefficient vehicles, outdated repair and maintenance facilities, lack of spare parts and inadequate training. Vehicle test centers are very poorly equipped.

GOG needs to take the following fuel savings potential measures in the sector:

- legislation to ensure fuel-efficient vehicles and their adequate inspection and servicing;
- enforcing minimum efficiency standards for the existing fleet;
- improving vehicle maintenance through better nationwide test-service facilities and adequate staffing and training;
- improving road maintenance.

GOG has come out over the years with steps to address the above issues by levying taxes on vehicles to be registered that do not conform to specific requirements. Considerable road rehabilitation has been underway to reduce vehicle running costs. In addition, NEB is undertaking projects to assess potential energy conservation in the sector in order to establish energy consumption pattern for planning purposes.

In 1989, the Ministry of Fuel and Power also set up a 14-member oil committee to study the petroleum industry. The study is to address the inefficient main transportation of petroleum to and from Tema refinery, processing at the refinery, road tanker delivery systems, final stages of produce distribution and receiving terminals and retail services stations and re-seller outlets. The committee is to establish a systematic basis for reducing losses at all stages of operations in the country. The implementation has enabled the Ministry of Fuel and Power to cut oil losses by 18,000 tonnes in the first half of 1990.

7. THE PRIVATE SECTOR IN ENERGY

Part of the Economic Recovery Program has been dealing with the reduction of government involvement in many socio-economic activities by leaving them to the private sector. Among the GOG's priorities is the promotion of massive private investment in the economy. Favorable investment codes and dialogues with prospective investors are being pursued to attract both foreign and local entrepreneurs into the vital economic sectors.

In the petroleum sector, the GOG has done a lot of groundwork to reactivate foreign private interests in hydrocarbon exploration in the country. GNPC and the Ministry of Fuel and Power have been responsible for the negotiation of contracts with private firms. Some of the private firms involved in petroleum exploration in Ghana are: AMACO/SIGNAL consortium, AGRI-PETCO, Primary Fuels Inc., Braspetro, MESA Petroleum, Texas Pacific, Phillips Petroleum, etc. These firms have been involved in all aspects of petroleum exploration and are expected to be prominent in the exploration of any discovered hydrocarbon deposits. Apart from the state-owned GOIL, distribution of petroleum products has been in the hands of the private sector.

8. USAID and Other Donor Activities in the Energy Sector

The reported USAID involvement in the Energy Sector in Ghana, in recent times, dates back to 1979 when some funding was provided for testing solar crop dryers. During 1978-81, USAID was in joint funding with the Bank of Ghana and CSIR, BRRI in the demonstration of the feasibility of pyrolysis of organic residues as an economical source of energy in Ghana. Since then, USAID has apparently not been involved in energy activities in Ghana. The current energy scene in Ghana with its relationship to the country's stage of Economic Recovery Program fits well into AID's Policy on Energy Sector and AID's assistance, at this time, will make the right impact on the sector. The management of the forests of Ghana emerges as one of the areas AID can identify policy reform projects that can be funded through The Natural Resources Management (NRM). The research enthusiasm in renewable energy in the country is worth supporting by AID. The rural electrification program which aims at stimulating power based socio-economic activities in the country is another key activity AID can support. This, in complementing other donors or AID programs in the rural areas will result in more postive impact.

Since the inception of the government's Economic Recovery Program, the donor world has been approached for assistance by the GON and responses have been growing. A number of donors are in funding status of assistance. The World Bank with its subsidiaries has been playing the leading role in offering assistance. Other donors active in the Recovery Program are UN agencies such as, UNESCO, UNDP, UNIDO etc. and Commonwealth. Caisse Central de Cooperation Economic, Canadian International Development Agency, German Technical Cooperation etc. are also assisting in many sectors (see Annex A24). The donor fundings have

helped the country achieve significant measure of progress. But shortfalls in the funding of projects requires more support to complete or carry on other projects that will provide adequate infrastructure and support services for the development of the private sector.

9. Energy Sector and the Environment

The contemporary dawn of environmental conciousness has also put Ghana on the alert. GOG has taken action to respond to the effects of development process on the environment that results in biophysical modification and wastes generation. The Environmental Protection Council (EPC) has been set up to oversee environmental protection in the country. The council has initiated Environmental Action Plan (EAP) with the assistance of the World Bank, USAID and the British Overseas Development Assistance. The EAP is to culminate in government policy and laws on the environment. Meanwhile, all development projects are required to pass through the EPC for study before implementation. This enables EPC to ensure that negative environmental effects identified are adequately addressed in the project.

In the energy sector, priority area of deforestation as a result of woodfuel dependency is being taken on in the Land Management issues for addressing. Maintaining forest resources and preserving tropical forests have a regional significance. Ghana is one of the countries in the regional struggle against desertification and protection of nature in the West African countries, the Maghreb and the Sudan.

Biogas program also seeks to improve the sanitary environment of the urban poor areas. The current recovery of LPG project at Tema refinery will eliminate the pollution resulting from flarring 6,000 M.T. per annum of LPG into the air.The LPG promotion also aims at reducing the harmful effect of carbon dioxide emission from woodfuel use. Since solar energy utilization has little environmental effect, it is vigorously being pursued in the country as an alternate energy source. The northeastern part of the country is a needy area with respect to energy sources. Solar energy use is being actively studied for dissemination as one of the short term solution..

Poverty is another root cause of environmental degradation in the country. Preoccupation for basic needs of the population, invariably draws their attention from or makes them disinterested in environmental protection activities. The efforts to reach the rural population with inexpensive energy seeks to stimulate economic growth that will result in reducing rural poverty.

10. Conclusion

The analysis of the information available for the energy sector in 1990 shows that the government of Ghana, in general, has adopted the recommendations put foward in the UNDP/World Bank Report. In-depth studies by Technical Assistants and host country experts have provided rational basis for formulating strtegies that has helped in negotiating agreements between the government and the World Bank on reforms. The government energy policies were, therefore, shaped accordingly. The studies further enabled the preparation of projects prioritized for execution under the Economic Recovery Program. The Government has put in place Public Investment Program which is a rolling program for five years 1989-93. For each budget year, the program revises the status of the investment programs under the ERP. The energy institutions are undergoing a considerable strengthening and their steady improvement has already placed them in the position to execute the programs of ERP. Program for appropriate mix of energy sources and end-use efficiencies are progressing satisfactorily. Environmental issues are receiving adequated attention both by funding donors and the Ghana Government.

The energy situation also shows that adequate policy framework and priority actions to be taken to advance reforms and projects are in place. The energy projects developed are in harmony with the GOG's policy and they promise to help bring about sustained energy sources to support the socio-economic development of Ghana. The National Energy Board is playing its role efficiently and its impact is contributing to the rapid progress the country is making in the sector. Shortfall in funding is the main constraint to the timely implementation of the programs under the ERP. For 1989-91, funding shortfall of projects is 39,726 million cedis in foreign exchange and 1,459 million cedis in local currency. In the current PIP, the energy sector is taking the largest share of public investment. Energy projects investment, in 1990, is 44,064 million cedis for 38 projects. This represents 25% of the total public investment cost, an indication of the priority position it occupies in the ERP. Progress in the sector is another shining example for Ghana under the ERP.

Although recent overall annual energy supply growth rate figures are not available, the government's growth rate target of 7.5% in 1988-91 is attainable. The commitment of the the government to development of the sector and the rapid progress of improvement in the sector already accomplished, shows that the government's target of 10% for 1991-1997 and 2% above projected GDP in the long- term of the overall supply growth rate are feasible.

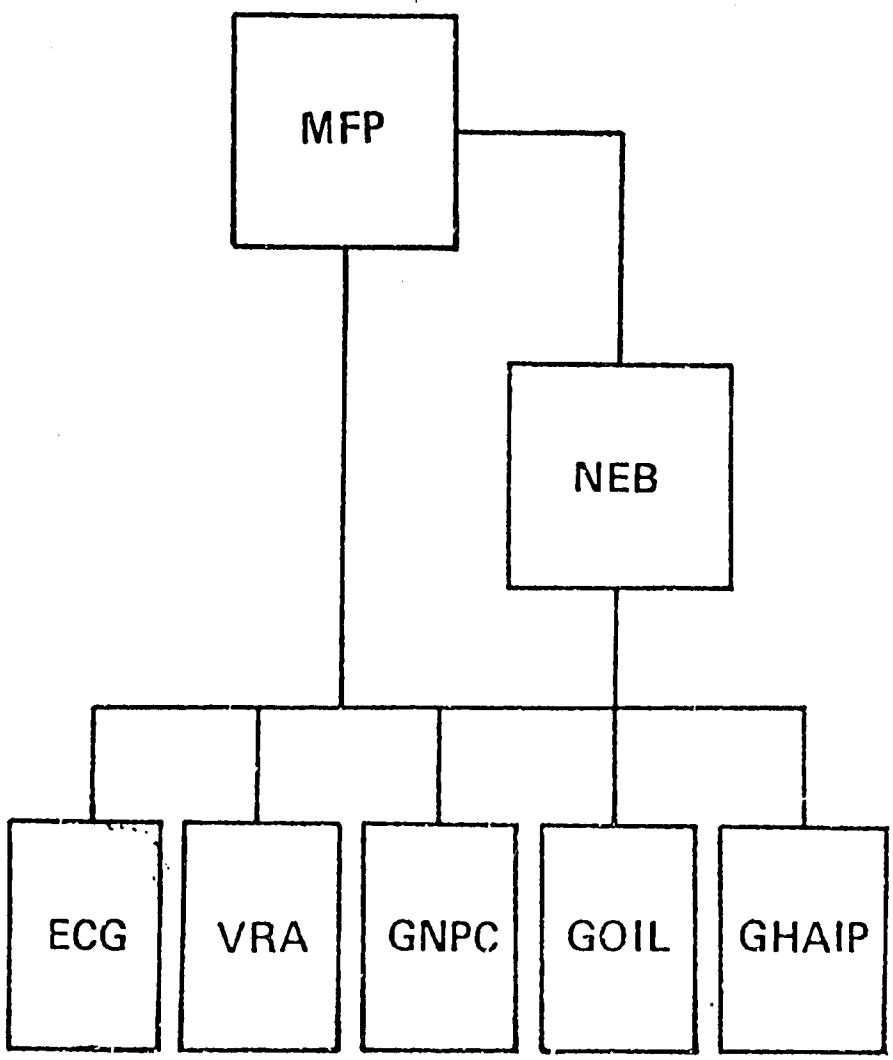
ANNEX A-1

ECONOMIC TRENDS

GROSS DOMESTIC PRODUCT, GROSS NATIONAL PRODUCT AND NATIONAL INCOME

	AT CURRENT PRICES (Million Cedis)				AT CONSTANT PRICES OF 1975 (Million Cedis)			
	1980	1983	1985	1986	1980	1983	1985	1986
Gross Domestic Product (GDP)	42,852.9	184,038.4	372,981.6	550,515.0	5,537.5	4,747.4	5,420.1	5,701.9
Annual Growth Rate of GDP (%)					6.2	−4.6	5.1	5.2
Per Capita GDP	3,860.0	15,150.9	29,554.8	42,347.3	498.9	390.8	429.5	438.6
Private Final Consumption Expenditure	35,952.7	167,147.1	284,621.0	437,424.7	4,252.5	3,442.8	4,181.4	4,321.1
Government Final Consumption Expenditure	4,784.4	10,787.0	32,241.0	56,595.6	981.5	990.0	835.3	849.5
Gross Fixed Capital Formation	2,613.1	6,922.1	32,688.5	49,087.5	516.1	344.3	489.2	472.7
Increase In Stocks	−202.9	−20.8	138.9	340.1	−25.5	−0.6	1.3	2.0
Exports of Goods and Services	3,628.1	10,225.0	33,185.0	76,984.0	654.5	373.3	435.1	616.2
Imports of Goods and Services	3,922.5	11,022.0	39,826.0	69,881.0	841.6	402.4	522.2	559.6
Net Factor Income from Abroad	182.4	1,640.0	5,768.6	12,576.0	54.4	30.3	75.6	100.7
Gross National Product	42,670.5	182,398.4	337,279.8	537,939.0	5,483.1	4,717.4	5,344.5	5,601.2
Consumption of Fixed Capital	1,511.7	4,196.9	16,338.8	29,267.1	312.3	328.8	298.7	294.4
National Income (at mkt prices)	41,158.8	178,201.5	320,941.0	508,671.9	5,170.8	4,388.6	5,096.2	5,306.8
Per Capita National Income	3,708.0	14,670.4	25,431.1	39,128.6	465.8	361.3	399.8	408.2
Current Transfers Received from Abroad (Net)	219.1	2,200.0	7,421.1	20,016.0	54.6	53.7	97.3	160.3
Total National Disposable Income	41,377.9	180,401.5	328,362.5	528,687.9	5,225.4	4,442.3	5,143.1	5,467.1

Source: Ghana in Figures Statistical Service

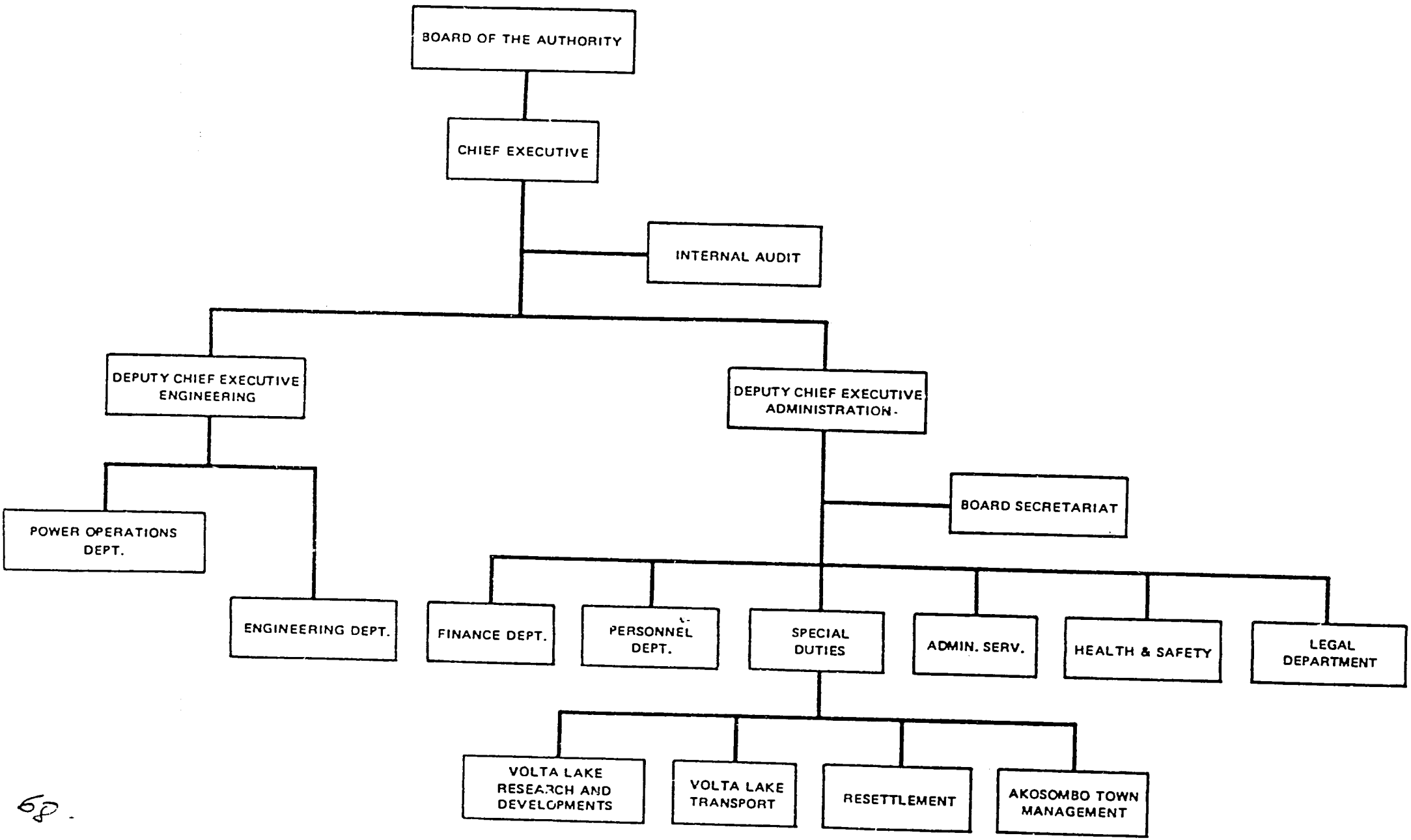


NATIONAL ENERGY BOARD
(NEB), GHANA.

AND NATIONAL ENERGY ORGANIZATIONS

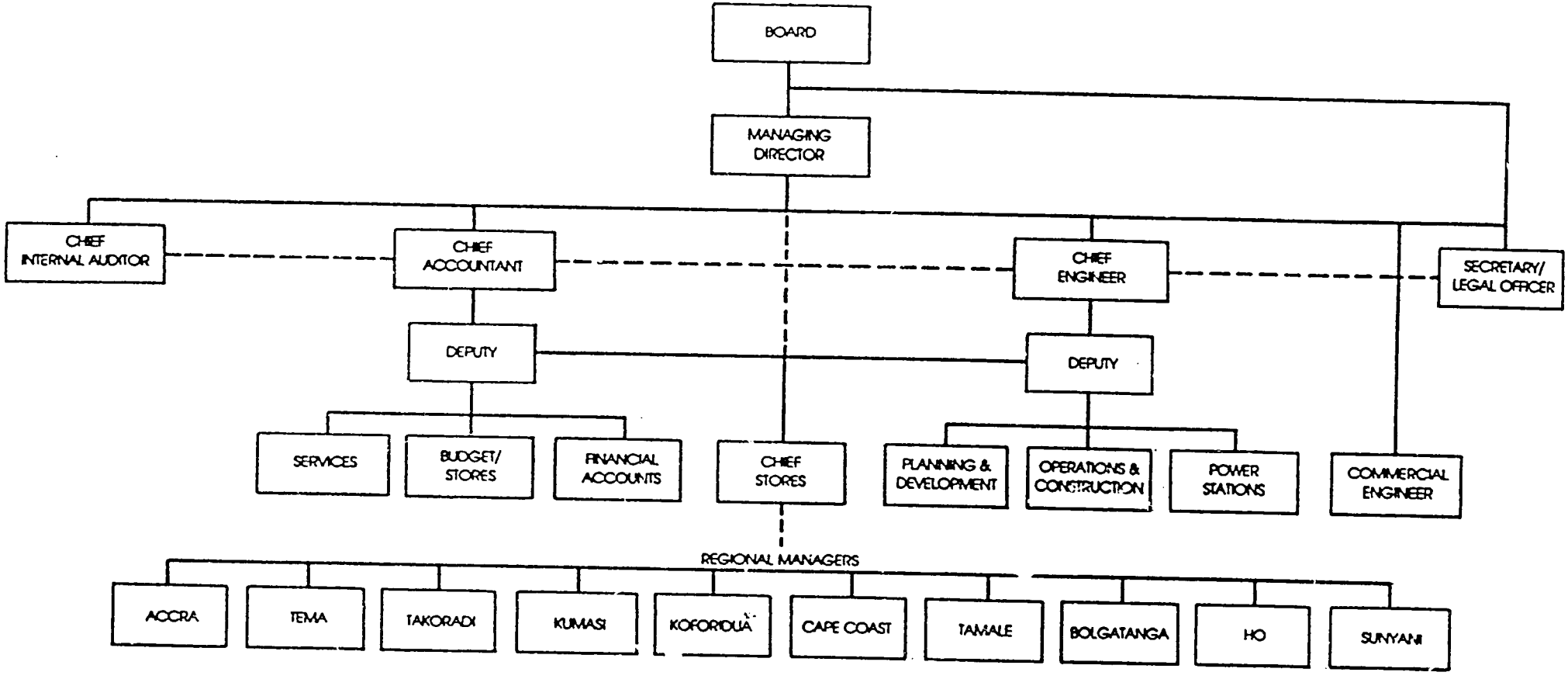
GHANA

Volta River Authority Organization Chart



GHANA

Electricity Corporation of Ghana
Organization Chart



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The University of Science & Technology Research Institutions

a. Department of Mechanical Engineering

The Department has been the leading energy research center in the country with focuses on Solar Energy Laboratory, technological development and evaluation of thermal solar systems. Their work covers solar cooking, solar drying, solar water heating, solar distillation, solar refrigeration and solar pumping. They are also involved in biomass technologies for power generation and development of improved cook stoves and also alternative biomass fuels for domestic use. The Department has a high level of expertise with enthusiasm but equipment and research funds are their constraints.

b. Department of Planning

Forests Management and Land-Use Conservation form part of the Department's courses offered in Resources Management. Its energy research activities has focussed on Project Appraisal, principally the evaluation of the economic competitiveness of the various energy technologies being demonstrated in Ghana. The Department has started to emphasize wood energy in the teaching and research programs.

c. Department of Agricultural Engineering

The Department has been involved in energy research on biomass and solar technologies for agricultural purposes involving integrated biogas systems and solar crop drying up. It has a collaboration agreement of the German Agency for Technical Cooperation (GTZ) who offers a reasonable level of funding support for the energy research.

d. Institute of Renewable Natural Resources

The Institute is funded by the Ministry of Lands and Natural Resources, even though it is a constituent institution of the University of Science & Technology for certification and degree purposes. It was established in 1982 and it has academic departments of Fisheries, Silviculture, Range Management, Forestry and Wood Technology. The main energy research activities are incorporated in student's projects and dissertations covering principally issues of fuelwood and charcoal production and consumption.

e. Forest Products Research Institute

The Institute was established in 1963 to undertake research on forests and forest products. Its energy research activities involve: a) assistance to charcoal producers and wood energy users to establish woodfuel plantations, including offering advice on species, soil, cultivation patterns etc. b) commercial utilization of charcoal to produce activated carbon for refinery processes; c) woodfuel production

and consumption surveys of specific end-use groups; d) research into reforestation and other woodfuel supply strategies. Its previous activities have included laboratory-scale production of charcoal briquettes from sawdust, production of sawdust briquettes and improved charcoal production techniques, especially with bricks and pit-kilns.

d. The Building & Road Research Institute

The Institute was created in 1963 to undertake research and development on building and road design and construction. The Materials Division has developed energy research interests and capabilities mainly in the area of technical demonstration and evaluation of biomass technologies. It has been involved in projects on pilot plant analysis of the pyrolysis of sawdust and wood shavings, the briquetting of pulverised char and the development of pulverised char stoves.

INVENTORY OF ON-GOING ENERGY RESEARCH IN GHANA

HARDWARE ORIENTED

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			Agric Eng./UST	"	Active
	(b) Industrial hot water	(i) Double-glazed flat plate, thermosiphon heater	Mech. Eng./UST	Lab Prototypes	Initiated in 1988, Active.
			Agric Eng/UST	"	
		(ii) linear parabolic concentrator	Mech. Eng./UST	Prototype	Started in 1985, still active.
	(c) Crop drying	(i) Natural convection cabinet dryers	Mech. Eng./UST	Prototype	Active
			Physics Dept/UG	"	"
			Home Science/UG	"	"
			FRI/CSIR	"	
			Agric. Eng./UST	"	
			DRHCI		Planned
		(ii) Natural convection, flow-thru dryer	Mech. Eng./UST	Prototype	
			Home Science/UG	"	
			FRI/CSIR	"	
			Agric Eng./UST	"	
			Physics Dept/Legon	"	
			Nutrition & Food Science/UG	"	
		(iii) Forced convection dryers	Mech. Eng./UST	Prototype	Active
			Agric. Eng./UST		

(d) Cooking	(i) Paraboloid concentrator	Mech. Eng./UST	Lab. Prototype	Active
	(ii) Flat plate steam cooker	"	Prototype	
	(iii) Linear parabolic concentrator	"	"	
(e) Water supply	(i) Open cycle steam injection pump with linear parabolic concentrator/steam generator	"	Prototype	
	(ii) Fractional power steam engine		"	
	(iii) Minimum maintenance solar pump (MMSP)	Mech. Eng./UST	"	
(f) Distillation distilled water	(i) Portable solar still		"	
(g) Food storage/ preservation/cooling	(i) $CaCl_2$-NH_3 Solid absorption refrigerator	Mech. Eng./UST	Prototype	Under further development
	(ii) Evaporative coolers	Mech. Eng./UST Agric. Eng./UST	Prototype "	Active
(h) Solar cell	(i) Liquid-liquid junction	Physics Dept./UST	Basic Lab. Investigation	
(i) Lumber dying	(i) Lumber dyer natural circulation	FPRI/FC	Prototype	

ERGY SOURCE	END-USE/PRODUCT	CONVERSION DEVICE	INSTITUTION	STATUS	REMARKS
2. BIOMASS	(a) Cooking	(i) Charcoal stoves	NEB/World Bank	Field Testing	Started 1989
			Mech. Eng/UST	Prototypes	Lab. testing in progress
			Home Science/UG	Prototypes	Active
		(ii) Sawdust stoves	Agric. Eng./UST	Commercial	Produced in Dept. Workshop
		(iii) Wood gasifier	Agric. Eng./UST	Prototype	Active, 1982
		(iv) Woodfuel stoves	Mech. Eng./UST	Prototype	Started 1989
			Rural Housing and Cottage Ind.	Pilot/ Demons-	
	(b) Lighting	(i) Gasifier/gas lamp	Agric. Eng./UST	Prototype	
		(ii) Biogas digester/gas lump	IRI/CSIR	Prototype	
	(c) Steam generation	(i) Wood-fired boiler	Mech.Eng./UST	Prototype	
	(d) Heating/Oil/Gas	(i) Pyrolytic convertor/thermal	BRR	Prototype	Started 1978 Active
	(e) Vegetable fuel	(i) Diesel engines	Mech. Eng./UST	Experimental	Active
			Biochemistry/UST	Laboratory	Screening local oil
	(f) Energy crops	(i) Energy farms/agro forestry woodlots	IRNR/UST	Demonstration	Active

(g) Briquetting	(i) Charred wood shavings/powdered charcoal	BRRI/CSIR	Laboratory	Active
	(ii) Converting well-binding sawdust	FPRI	Laboratory	Active
(h) Alternative tree species for charcoal production		FPRI	Planning stage	
(i) Improved charcoal production methods		FPRI		

The University of Ghana Research Institutions

1. Department of Home Science

The Department takes on energy research as part of its teaching and extension activities mainly on needs of rural domestic and small-scale industrial users. It has evaluated the effectiveness and impact of improved cookstoves on energy and other domestic activities. Testing and evaluation of locally-developed solar dryers for their performance and adaptability to intended users.

2. Department of Physics

The Department's main interest in energy research has been on solar energy systems. Its work covers analysis of radiation data, the development, demostration and evaluation of solar crop dryers, solar water heaters and photovoltaic systems for rural application.

3. Department of Agricultural Engineering

The Department's energy activities focus on solar dryers and integrated biogas systems. Other activities involve evaluation and development of solar cookers and water heaters.

4. Department of Food & Nutrition Science

The Department deals mainly in two energy areas: a) improvement to food quality through the use of solar crop dryers; b) conservation of domestic energy through pre-cooking process that would reduce the cooking times for staple foods such as beans.

5. Department of Geography

The Department's energy interest is mainly in the socio-economic impacts of energy use in Ghana. Its activities include the impacts of transportation costs on woodfuels supply and marketing.

TABLE 2.1
CHARCOAL PRODUCTION AREAS IN GHANA

SCALE OF PRODUCTION	LOCATION OF PRODUCTION AREA-WITHIN 50KM RADIUS FROM TOWNS BELOW	REGION	VEGETATION ZONE	MAIN MARKETS	RANGE OF DISTANCE FROM PRODUCTION AREAS TO MARKETS, KM
Large	Kintampo	Brong Ahafo	Savannah Woodland	Kumasi/Accra	150-500
"	Atebubu	"	"	"	"
"	Nkoranza	"	"	"	"
"	Mampong	Ashanti	"	"	100-400
"	Ejura	"	"	"	"
"	Donkorkrom	Eastern	"	Accra	250-500
"	Kpandu	Volta	"	"	200-400
"	Hohoe	"	"	"	200-300
"	Ho	"	"	"	150-200
"	Daboase	Western	Rain Forest	Sekondi-Takoradi/Accr	50-200
"	Kumasi	Ashanti	(*Sawmill Residue used for charcoal)	Kumasi	1-10
Medium	Axim	Western	Rain Forest	Takoradi/Axim	20-100
"	Tarkwa	"	"	Takoradi/Tarkwa	10-100
"	Agona Swedru	Central	Semi-deciduous Forest	Swedru/Accra	10-100
"	Nkwanta	Volta	Savannah Woodland	Accra	400-500
"	Mim	Brong Ahafo	(*Sawmill Residue used for charcoal)	Mim	1-10
Small	Cape Coast	Central	Semi-deciduous Forest	Cape Coast	10-50
"	Koforidua	Eastern	Semi-deciduous Forest	Koforidua	10-50
"	Akim Oda	"	"	Akim Oda	10-50
"	Tamale	Northern	Savannah Woodland	Tamale	10-50
Very Small	Bolgatanga	Upper East	"	Bolgatanga	10-50
"	Wa	Upper West	"	Wa	10-50

SOURCE: Charcoal Cycle in Ghana,
National Energy Board

MOVEMENT OF BAGS OF CHARCOAL BY HEADLOADING, CANOE, AND TRACTOR TO ROADSIDE

SERIAL NO.	CHARCOALING POINT	ADMINISTRATIVE REGION	HEADLOADING COST TO ROADSIDE (CEDIS)	COST OF MOVEMENT TO ROADSIDE BY TRACTOR	SELLING PRICE AT ROADSIDE	MOVEMENT TO ROADSIDE EXPRESSED AS % OF SELLING PRICE
1	ABRAFO	CENTRAL	120	-	1200	10
2	NSABA	CENTRAL	50	-	650	8
3	BONSA	WESTERN	120	-	800	15
4	KWANKROM	WESTERN	200	-	900	22
*5	BEYOND GYEMINI	EASTERN & VOLTA	200	-	600	33
6	VE-GOLOKUATI	VOLTA	100	-	700	14
7	EJURA	ASHANTI	-	100	200	50
8	MAMI KROBO	EASTERN (AFRAM PLAINS)	-	100	500	20
9	TEASE	EASTERN (AFRAM PLAINS)	-	200	500	40
10	NYANSORO ZONGO	BRONG-AHAFO	-	80	300	25

Movement cost by canoe.

SOURCE: Charcoal Cycle in Ghana, National Energy Board

CHARCOAL CONSUMPTION BY URBAN HOUSEHOLDS

REA	** POPULATION	AGGREGATE DEPENDENCE ON CHARCOAL %	AVERAGE H/H SIZE FOR CHARCOAL USERS	MEALS/DAY FOR CHARCOAL USERS	PER CAPITA CHARCOAL CONSUMPTION KG/PERSON/DAY	ANNUAL CHARCOAL CONSUMPTION METRIC TONS
UMASI	440,753	85.9	6.25	1.99	0.5161	71,320.629
OFORIDUA	59,814	61.9	5.82	2.22	0.4067	5,496.175
OHOE	21,378	43.9	5.71	2.16	0.4048	1,386.644
CCRA	1,085,731	71.6	5.96	2.04	0.4974	141,134.733
O	37,870	61.4	5.56	2.36	0.4504	3,822.565
KAWKAW	37,494	56.9	5.63	2.19	0.5391	4,197.940
EMA	149,395	68.6	6.38	2.24	0.3631	13,582.487
SHIAMAN	56,251	85.1	5.51	2.09	0.3882	6,782.787
BUASI	66,340	75.0	5.38	2.05	0.5543	10,066.407
SAWAM	35,075	42.6	5.24	2.29	0.594	3,239.564
APE COAST	61,968	65.7	5.24	2.29	0.5162	7,670.854
AKORADI	79,207	78.4	5.62	2.18	0.4747	10,759.491
EKONDI	61,185	77.1	5.19	2.21	0.5013	8,631.572
UNYANI	40,789	67.1	6.47	2.46	0.5207	5,201.709
ENCHI	20,790	81.7	7.21	2.42	0.5463	3,386.886
OLGATANGA	34,771	72.6	5.80	2.56	0.6464	5,955.908
AWKU	37,420	46.9	7.14	2.36	0.4456	2,854.399
AMALE	156,376	51.6	6.16	2.46	0.5578	16,428.245
A	39,421	61.2	8.25	2.54	0.5834	5,137.340
OTALS	2,522,028					327,056.336
*URBAN GHANA	4,360,198	68.8	6.64	2.26	0.4954	542,429.769

* Extrapolated total consumption for Urban Ghana could be higher; a more realistic estimate puts it 476.8 thousand metric tonnes.

** Based on 1984 Census data.

SOURCE: Charcoal Cycle in Ghana

PROJECTED HOUSEHOLD ENERGY CONSUMPTION
ACTION-ORIENTED SCENARIO

	1985				Projected 1990				Projected 1995			
	Physical Units	TOE Equiv. ('000)	Efficiency (%)	Useful Energy (TOE)	Physical Units	TOE Equiv. ('000)	Efficiency (%)	Useful Energy (TOE)	Physical Units	TOE Equiv. ('000)	Efficiency (%)	Useful Energy (TOE)
URBAN												
Total Energy Consumption		600.5		130.0		752.0		175.4		912.6		235.2
--per capita/y. (adj. kgoe)				31.1				32.6				34.3
Fuelwood (M.T.'000)	538.8	183.2	10.0	18.3	842.9	286.6	10.5	30.1	1,043.0	354.6	13.0	46.1
Charcoal (M.T.'000)	450.0	306.0	20.0	61.2	497.4	338.2	24.2	81.9	602.7	409.8	26.5	108.8
Kerosene (M.T.'000)	69.9	70.8	35.0	24.8	76.3	77.4	38.3	29.6	85.3	86.3	41.7	36.0
LPG (M.T.'000)	3.1	3.3	45.0	1.5	4.9	5.3	48.3	2.6	7.8	8.3	51.7	4.3
Electricity (GWh)	438.0	37.2	65.0	24.2	523.6	44.5	70.0	31.2	630.3	53.6	75.0	40.2
RURAL												
Total Energy Consumption		1,608.1		169.7		1,705.0		196.6		1,650.3		225.8
--per capita/y. (adj. kgoe)				18.7				19.6				20.6
Agric. Residues (M.T.'000)	471.6	138.7	10.0	13.9	517.3	152.1	10.5	16.0	543.7	159.9	12.0	19.2
Fuelwood (M.T.'000)	4,217.8	1,434.1	10.0	143.4	4,399.4	1,495.8	10.5	157.1	4,142.2	1,408.3	12.0	169.0
Kerosene (M.T.'000)	34.9	35.3	35.0	12.4	51.1	51.6	38.3	19.8	69.7	70.6	41.7	29.5
LPG (M.T.'000)	-	-	-	-	0.6	0.6	48.3	0.3	1.9	2.0	51.7	1.0
Electricity (GWh)	-	-	-	-	57.6	4.9	70.0	3.4	111.5	9.5	75.0	7.1

Source: Ministry of Fuel and Power; Forestry Commission; FAO; mission estimates.

PROJECTED WOODFUELS REQUIREMENTS, 1990; 1995
(M.T. '000)

	Estimated 1985	1990	1995
I. ACTION-ORIENTED SCENARIO			
Fuelwood	5,344.0	5,967.6	6,063.4
Industry/Mining	176.1	224.8	273.4
Agriculture/Fishing	117.5	143.0	169.8
Commercial/Government	293.8	357.5	434.9
Residential	4,756.6	5,242.3	5,185.2
Charcoal	460.0	507.4	614.3
Commercial/Government	10.0	10.0	11.6
Residential	450.0	497.4	602.7
Charcoaling Efficiency (%; Weight Basis)	14.0	16.0	18.5
Charcoal, Fuelwood Equiv.	3,285.7	3,171.9	9,383.9
Total Woodfuels Requirements	8,629.7	9,138.9	9,383.9
II. TREND-BASED SCENARIO			
Fuelwood		6,417.4	7,791.2
Industry/Mining		235.7	300.8
Agriculture/Fishing		146.4	179.9
Commercial/Government		375.0	478.6
Residential		5,660.3	6,831.9
Charcoal		546.2	633.3
Commercial/Government		11.0	13.0
Residential		535.2	620.3
Charcoaling Efficiency (%; Weight Basis)		14.0	14.0
Charcoal, Fuelwood Equiv.		3,901.8	4,523.2
Total Woodfuels Requirements		10,319.2	12,314.4

Source: Ministry of Fuel and Power; Forestry Commission; FAO; mission estimates.

SOURCES AND PRICES OF CHARCOAL IN THE REGIONAL CAPITALS (MAY - SEPT. 1988).

REGIONAL CAPITAL	MAJOR SUPPLY SOURCES	WEIGHT / MAXI BAG, KG	PRICE / MAXI BAG CEDIS	RETAIL PRICE CEDIS/KG
ACCRA	Adaklu (Ho), Logba, Kpandu Gemani(Bruben)	50-60	1100-1300	30.31
	Kintampo, Subinso, Nkoranza Afram Plains, Amponsakrom, Ekumfi, Mampong, Ejura	35-49	1100-1300	30.31
KUMASI	Kintampo, Ejura, Nkoranza Atebubu, Babatorkuona, Mampong	36-52	800-900	21.89
	Kumasi Sawmills	22-40	600-650	17.14
CAPE COAST	Jukwaa Area, Efuta, Praso Mankesim, Bibrimso, Abura Dunkwa	56 49 25-32	1600-1800 1200-1400 800-900	40.31
SEKONDI TAKORADI	Ahanta Area, Nzema Area Wassaw Area, Daboase, Kodadwene	38-55 35.2-58.3	1200-1600 1100-1400	40.18 32.98
SUNYANI	Kintampo, Subinso, Nkoranza Yamfo, Amponsakrom, Tanoso	31-59	800-1000	27.08
KOFORIDUA	Afram Plains, Huhunya, Asesewa Dwumapo	47-58	900-1000	31.53
HO	Adaklu, Takla, Akrofu, Hodjo	25-28 *	400-500	26.90
	Kajeebi, Mafe-Kumasi, Krachi, Bonakyi	39-46	750	-
TAMALE	Walewale, Gushiegu, Kpalebge, Fu, Sang	45-54	600-700	19.87
BOLGATANGA	Lamgbushie, Zangma, Wulugu, Walewale	42-58	1000	23.67
WA	Darimon, Pirisi, Sankama Kaleo, Jung, Goli Guo, Kpadema Busa	44-47	500-600	23.69

SOURCE: Charcoal Cycle in Ghana

CONSUMPTION PATTERN OF PETROLEUM PRODUCTS

INLAND ENERGY CONSUMPTION	1980	1982	1984	1985	1986
Crude Oil ('000 mt)	1057.52	1040.40	746.74	965.60	883.31
nsumption of Petroleum Products ('000 mt)					
Residual fuel oils	49.54	38.93	26.74	16.33	24.17
Gas oil	282.26	255.56	252.78	282.84	284.42
Gasoline	245.67	247.61	182.58	220.36	227.15
Industrial diesel	6.48	3.10	0.63	1.42	1.08
Inland fuel oil	26.36	36.53	22.40	11.79	23.88
L. P. G.	6.94	6.39	4.35	5.12	6.22
Kerosine and A.T.K.	159.44	157.32	108.96	138.32	142.53

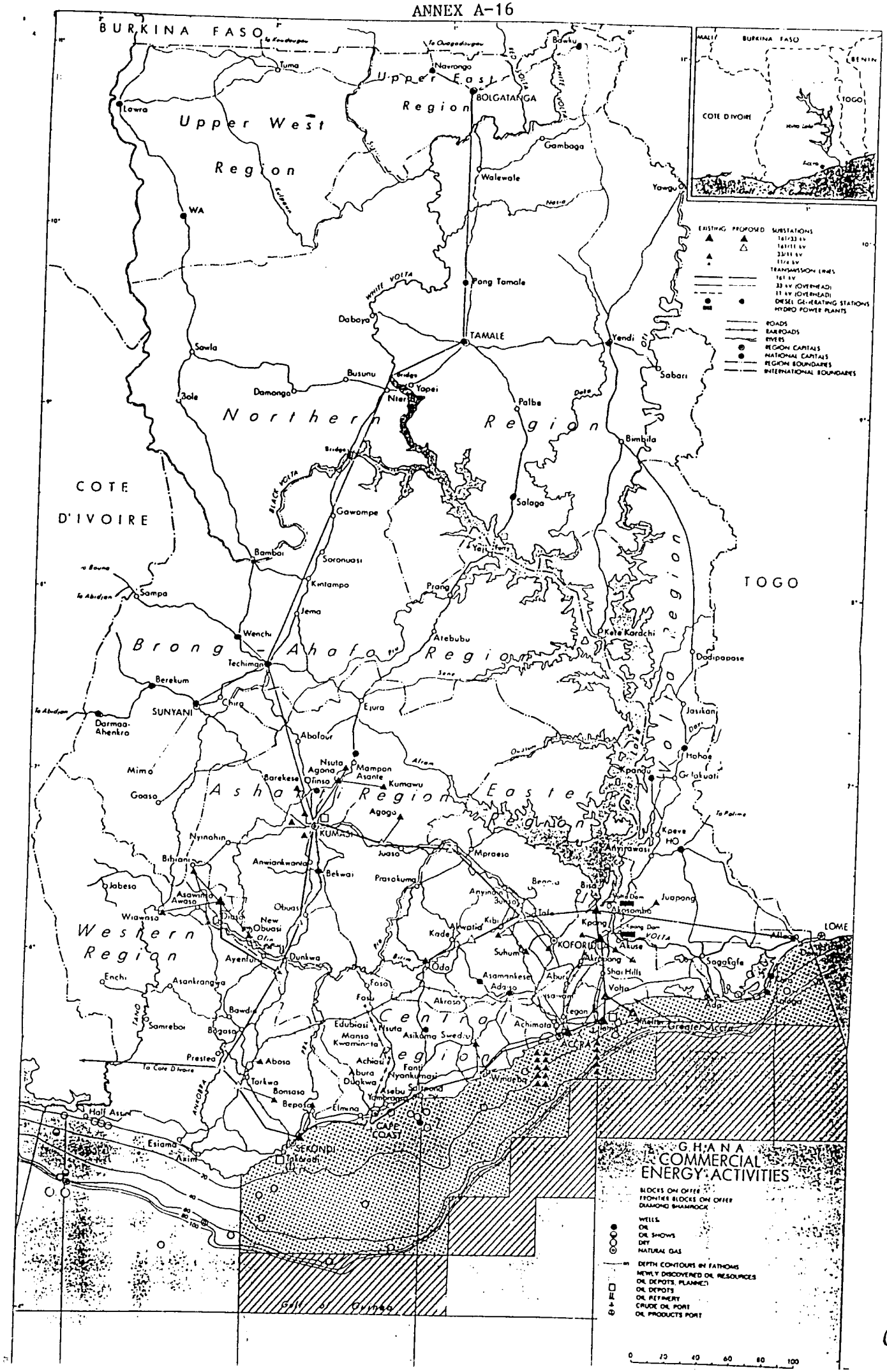
SOURCE: Ghana in Figures 1987, Statistical Service

ECONOMIC COST AND OFFICIAL PRICES OF PETROLEUM PRODUCTS, 1985-86
(₵ per Imperial Gallon Unless Otherwise Indicated)

	Economic Cost				Average Retail Price	Net Difference	1985 Estimated Consumption	1985 Estimated Economic Surplus or Loss (-)	
	CIF Import Cost US$/M.T. (1)	CIF Import Cost ₵/i.G. (2)	Internal Cost (3)	Total Cost (4)	(5)	(6)	(M.T. '000) (7)	(₵ millions) (8)	(US$ '000 equiv.) (9)
DECEMBER 1985									
LPG	230	10.45 a/	3.64 a/	14.09 a/	10.16 a/	-3.93 a/	4.1	-35	-355
Premium Gasoline	280	96.55	11.10	107.65	105.00	-2.65	172.2	-132	-1,324
Regular Gasoline	265	89.08	11.10	100.18	100.00	-0.18	48.5	-3	-25
Kerosene	267	98.16	11.10	109.26	55.00	-54.26	113.9	-1,681	-16,811
Jet Fuel	267	98.16	5.80	103.96	80.00	-23.96	24.4	-159	-1,590
Gas Oil	246	89.78	11.10	100.88	85.00	-15.88	306.5	-1,334	-13,337
Industrial Diesel	223	84.96	0.76	85.72	70.00	-15.72	1.4	-6	-57
Inland Fuel Oil	176	73.87	0.83	74.70	53.00	-21.70	11.5	-59	-591
Residual Fuel Oil	58	71.79	0.84	72.64	40.00	-32.64	16.8	-128	-1,283
TOTAL									-35,374
JANUARY-SEPTEMBER 1986									
LPG	200	13.61 a/	4.85 a/	18.46 a/	15.15 a/	-3.31 a/	4.1	-30	-199
Premium Gasoline	171	88.46	13.95	102.41	150.00	47.59	172.2	2,376	15,842
Regular Gasoline	156	78.67	13.95	92.62	145.00	52.38	48.5	757	5,047
Kerosene	163	89.91	13.95	103.86	80.00	-23.86	113.9	-739	-4,927
Jet Fuel	163	89.91	7.00	96.91	135.00	38.09	24.4	253	1,685
Gas Oil	154	84.25	13.95	98.20	130.00	31.80	306.5	2,671	17,807
Industrial Diesel	135	79.44	0.95	80.39	100.00	19.61	1.4	7	48
Inland Fuel Oil	96	60.44	1.04	61.48	70.00	8.52	11.5	23	155
Residual Fuel Oil	89	57.05	1.05	58.11	65.00	6.89	16.8	27	181
TOTAL									35,639

Note: Shadow exchange rate: ₵100/US$ (December 1985) and ₵150/US$ (September 1986).
a/ per lb.

Source: Ministry of Fuel and Power; mission estimates.


BURKINA FASO
Upper West Region
Upper East Region
BOLGATANGA
Navrongo
Tumu
Lawra
WA
Gambaga
Walewale
Yagbum
Pong Tamale
TAMALE
Daboya
Sawla
Yendi
Sabari
Busunu
Damongo
Yapei
Nteri
Palbe
Bimbila
Jole
Northern Region
COTE D'IVOIRE
Salaga
Gawompe
Bambai
Soronuasi
Kintampo
Prang
Sampa
Jema
Wenchi
Atebubu
Kete Krachi
Brong - Ahafo Region
Techiman
Dodipapase
Berekum
SUNYANI
Chira
Ejura
Jasikan
Darmaa-Ahenkro
Abofour
Nsuta
Agona
Mampon Asante
Kumawu
Barekese
Ofinso
Mimo
Goaso
Ashanti Region
Eastern Region
Kpandu
Agogo
KUMASI
Nyinahin
Kpeve
HO
Anyanawasi
Bibiani
Anwiankwanta
Bekwai
Juaso
Mpraeso
Prasokuma
Jabesa
Asawinso
Awaso
Wiawso
Obuasi
New Obuasi
Western Region
Ayenfuri
Dunkwa
Kade
Kwadwo
Suhum
KOFORIDUA
Aburi
Akosombo
Juapong
Kpong
Aflao
LOME
Saga Lafe
Shai Hills
Volta
Ada
Enchi
Asankrangwa
Odo
Asamankese
Adaso
Akroso
Tegan
Bawdie
Samreboi
Bogoso
Fosa
Edubiasi
Nsuta
Asikuma
Swedru
Manso Kwamankese
Achimota
Greater Accra
Prestea
Abosa
Achiasi
Fanti
Abura
Nyankumasi
Dunkwa
Tarkwa
Bonsaso
Asebu
Saltpond
Winneba
Bepotso
Elmina
CAPE COAST
Half Assini
Esiama
Axim
SEKONDI
Takoradi
Central Region
ACCRA
TOGO
Gulf of Guinea
GHANA
COMMERCIAL ENERGY ACTIVITIES
BLOCKS ON OFFER
FRONTIER BLOCKS ON OFFER
DIAMOND SHAMROCK
WELLS
OIL
OIL SHOWS
DRY
NATURAL GAS
DEPTH CONTOURS IN FATHOMS
NEWLY DISCOVERED OIL RESOURCES
OIL DEPOTS, PLANNED
OIL DEPOTS
OIL REFINERY
CRUDE OIL PORT
OIL PRODUCTS PORT
0 20 40 60 80 100

Existing Generation Facilities

VRA Hydro Plants	Units/Size	kW	kW
1. Akosombo	4 x 147 MW	588,000	
	2 x 162 MW	324,000	912,000
2. Kpong	4 x 40 MW		160,000
Total Hydropower			1,072,000

ECG Diesel Plants		
1. Asamankese	436	
2. Axim	215	
3. Bawku	565	
4. Berekum	798	
5. Bekwai	543	
6. Bolgatanga	4,154	
7. Breman-Asikuma	238	
8. Dormaa Ahenkro	224	
9. Keta	437	
10. Lawra	118	
11. Navrongo	876	
12. Pong Tamale	187	
13. Sunyani	3,426	
14. Suhum	360	
15. Tamale	4,994	
16. Techiman	512	
17. Tema	30,000	
18. Wa	920	
19. Wenchi	694	
20. Yendi	341	
Total Diesel Power		50,038
Total (Public System)		1,122,038

Captive Generating Capacity

Organization	Installed Capacity
Ashanti Goldfields	9,000
SGMC	5,300
Ghana Consolidated Diamonds	2,500
Korle Bu Hospital	2,500
Mim Timber	2,300
Ghana National Manganese	1,800
14 Organizations In Tamale Area	5,800
Total	29,200

SOURCE: ECG Fifth Power Project by World Bank, 1988

Region/ Met. Area	Towns/Villages under 33/11Kv lines	Self-help projects	Total
Tema	5	4	9
Accra	5	1	6
Western Region	6	13	21
Ashanti Region	12	17	29
Volta Region	6	17	23
Eastern Region	7	17	24
Central Region	22	20	44
T O T A L	63	93	156

Areas benefiting from Indian Credit

Source: PIP 1989 - 91

Rural Electrification Work Program 1989 - 91

ACTIVITY	PLANNED EXPENDITURES (IN ¢MILLION									
	1989		1990		1991		Bal to Comp		TOTAL	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
egional Electri-ication Studies		21								21
ational Electri-ication Studies (IDA)	50	30	80	20					130	50
ompletion of lectrification rojects under ndian Credit ine	416	100	624	110					1040	210
xtension of lectrification rid under apanese Grant.	160	100	400	100	500	50	860		1920	250
estern Region lectrification Yugoslavia)		100	460	100	380		1760		2600	200
ompletion of olta Region Elec-rification (KFW)	60		65						125	
lect. Supply to istrict Capitals	104	50		50					104	100
T O T A L	790	401	1629	380	880	50	2620		5919	831

SOURCE: Public Investment Program 1989 - 91

DISTRICT CAPITALS WITHOUT ELECTRICITY SUPPLY

ECG SUPPLY AREA

REGION	DISTRICT CAPITALS WITHOUT ELECTRICITY SUPPLY	
	FUNDING IN PLACE FOR EXTENSION	NO. FUND IN PLACE FOR EXTENSION
2.1.1 ASHANTI (7 TOWNS)	1. EJURA * 2. TEPA 3. KUNTENASI 4. BEKWAI	1. NEW EDUABIASE 2. MANSO NKWANTA 3. MANKRASO
2.1.2 EASTERN (2 TOWNS)		1. NEW ABIREM 2. DONKORKROM
2.1.3 VOLTA (6 TOWNS)	1. KETA	1. NKWANTA 2. KADJEBI 3. JASIKAN 4. AKATSI 5. SOGAKOPE 6. ADIDOME
2.1.4 G/ACCRA (2 TOWNS)	1. AMASAMAN	1. ADA FOAH
2.1.5 CENTRAL (3 TOWNS)	1. ASIKUMA	1. TWIFO PRASO 2. AJUMAKO
2.1.6 WESTERN (6 TOWNS)	1. AXIM 2. ASANKRAGUA 3. ENCHI 4. AGONA NKWANTA 5. HALF ASSINI 6. JUABESO	
TOTAL	13 TOWN	14 TOWNS

NB/* Covered by the on-going Northern Electrification and System Reinforcement Project.

SOURCE: Ministry of Fuel and Power

VRA/NED SUPPLY AREA

REGION	DISTRICT CAPITALS WITHOUT ELECTRICITY SUPPLY	
	** FUNDING IN PLACE FOR EXTENSION	NO. FUND IN PLACE FOR EXTENSION
2.2.1 BRONG AHAFO (13 TOWNS)	1. GOASO 2. DORMAA AHENKRO 3. BEREKUM 4. SUNYANI 5. DUAYAW-NKWANTA 6. TECHIMAN 7. NKORANZA 8. WENCHI 9. KINTAMPO 10. ATEBUBU	1. KWAME DANSO 2. DROBO 3. KENYASI NO. 1
2.2.2 NORTHERN (13 TOWNS)	1. TAMALE 2. YENDI 3. SAVELUGU 4. SALAGA 5. DAMANGO 6. BOLE 7. WALEWALE	1. GUSHIEGU 2. SABOBA 3. ZABZUGU 4. BIMBILLA 5. GAMBAGA 6 TOLON
2.2.3 UPPER EAST (6 TOWNS)	1. BOLGATANGA 2. BAWKU 3. NAVRONGO 4. SANDEMA 5. ZEBILLA !	1. BONGO
2.2.4 UPPER WEST (5 TOWNS)	1. WA 2. LAWRA	1. NADAWLI 2. JIRAPA 3. TUMU
TOTAL	24 TOWNS	13 TOWNS

NB/** Funding is invariably in place from co-sponsors of the on-going Northern Electrification and System Reinforcement Project.

! Proposed supply from shieldwire extension

SOURCE: Ministry of Fuel and Power

SUMMARY OF REGIONAL COST ESTIMATES

REGION	TOTAL COST IN US$			
	SUPPLY (CIF)		ERECTION	
	FOREX	LOCAL	FOREX	LOCAL
WESTERN	2838550	1252290	985150	716400
CENTRAL	508200	245650	199350	132750
G. ACCRA	502600	226400	182900	126300
VOLTA	4259400	1239006	1491670	735900
EASTERN	719300	461940	660250	330900
ASHANTI	1635700	693050	545350	396600
BRONG AHAFO	1053040	459950	363250	264000
NORTHERN	2936054	1446350	1247950	897900
UPPER EAST	287500	145350	99600	76500
UPPER WEST	2498200	434970	2170050	1555650
TOTAL	17238544	6604956	7945520	5232900

SOURCE: Ministry of Fuel and Power

ANNEX A-22

DISTRICT CAPTIALS WITHOUT ELECTRICITY SUPPLY

Complementary Assistance Sought

COST IN US DOLLARS

Region	District Capital	SUPPLY (CIF) Forex	SUPPLY (CIF) Local	ERECTION Forex	ERECTION Local
A. ECG SUPPLY AREA					
ASHANTI	New Eduabiase	486,600	211,400	167,700	121,550
	Manso Nkwanta	375,100	136,550	128,850	87,700
	Mankraso	159,100	55,850	47,850	33,700
EASTERN	New Abirem	564,100	146,990	149,300	106,250
	Donkorkrom	155,200	314,950	510,950	224,650
VOLTA	Nkwanta	236,800	337,550	263,100	191,950
	Kadjebi	150,700	58,200	53,200	37,100
	Jasikan	484,000	218,550	174,200	126,150
	Akatsi	354,900	167,500	119,570	90,450
	Sogakope	161,000	61,100	48,300	35,150
	Adidome	857,900	120,200	108,800	70,650
GREATER ACCRA	Ada Foah	466,500	206,500	169,300	117,250
CENTRAL	Twifo Praso	335,350	147,350	122,100	87,050
	Ajumako	172,850	98,300	77,250	45,700
B. VRA/NED SUPPLY AREA					
BRONG AHAFO	Kwame Danso	370,150	154,700	125,300	90,150
	Drobo	319,440	116,150	108,300	74,150
	Kenyasi No. 1	363,450	189,100	129,650	99,700
NORTHERN	Gugheigu	650,050	285,300	227,850	164,700
	Saboba	510,450	187,300	179,650	121,500
	Zabzugu	495,850	211,800	171,450	123,300
	Bimbiua	236,800	337,550	263,100	191,950
	Gambaga	802,604	323,250	309,250	225,850
	Tolon	240,300	101,150	96,650	70,600
UPPER EAST	Bongo	211,000	104,900	74,300	56,250
UPPER WEST	Nadawli	202,800	114,920	84,100	52,450
	Jirapa	206,650	79,000	73,300	38,650
	Tumu	2,088,750	241,050	2,012,650	1,464,550

SOURCE: Ministry of Fuel and Power

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NEW TECHNOLOGIES IN THE ENERGY SECTOR

S.NO.	Energy Source	Description	Manufactured/ Supplied by	End-users	Remarks
01	Woodfuels	Saw dust briquetting	Chawus Limited, Akim Oda.	Bakers, Institutions, Brick manufacturers	Price was ¢9,370.00 per tonne in 1986
		Saw dust stoves	(a) Agric. Eng. Dept.(UST (b) A Lang, Tema	Household, Small Commercial Users	
		Charcoal stoves	(a) Informal artisans (b) GIHOC Steelworks Tema (c) Agrico Al Afra	Household, Institutions, Commercial	
		Charcoal making	DL Steel, Ghana Limited	Commercial charcoal makers	
		Fish Smoking (Chorkor Smokers)	Users/Artisans	Fish Smokers	
02	Solar Energy	Photovoltaic System (Refrigerators, Communication, Water Pumps)	Over 5 Companies owe supplying equipment	P & T Corporation, Cocoa Board, Hospitals, Institutions	Price was ¢5,000-7,500 per tonne in 1983
	Water Heater	-do-		Hospitals	
03	Electricity	Cooking Stoves	Informal	Household	
		Refrigerators	(a) Informal (b) GNTC Technical	Households	
04	Petroleum	Kerosene Stoves	Informal	Household	

Donor Funding in Energy Sector ANNEX A-24

ENERGY - RENEWABLE

Improved Charcoal Stove Program

	(In Millions Cedis)
IDA/GTZ	70
Dutch Government	64
UNDP	16

Energy Efficiency Enhancement Program

UNDP	14
IDA/ESMAP	71
UNCTAD	11

Electrification and System Reinforcement

Consortium:

ABD
EIБ (European Investment Bank)
CIDA
Commonwealth Development Corporation
IDA
Saudi Fund
Kuwait Fund
Japan Exim Bank

20,884

SOURCE: Public Investment Program 1989 - 91

DONOR FUNDINGS IN ENERGY SECTOR

ENERGY - RENEWABLE

Improved Charcoal Stove Program

(In Millions Cedis)

IDA/GTZ	70
Dutch Government	64
UNDP	16

Energy Efficiency Enhancement Program

UNDP	14
IDA/ESMAP	71
UNCTAD	11

Electrification and System Reinforcement

Consortium:

ABD
EIB (European Investment Bank)
CIDA
Commonwealth Development Corporation
IDA
Saudi Fund
Kuwait Fund
Japan Exim Bank

20,884

Power System Rehabilitation Phase II

	(In Millions cedis)
Italian Government	2,289
Rehabilitation of Tema Diesel Plant	
British Technical Assistance	1,878
U.K. (To be negotiated) 1990	116
T.A./Training Center for VRA	
IDA	1,837
Danish Government	56
Anti-Corrosive Painting of Akosombo Plant	
IDA	496
New Thermal Generating Station (200 MW)	
CPPF (Canadian Project Preparatory Fund)	99
ACRES	17
Consortium (EIB, EXIM Bank of Japan, to be negotiated Commonwealth Development Corp.)	
	0,760

.96

AKOSOMBO GENERATING STATION REHABILITATION

	(In Millions Cedis)
To negociate (ODA)	500
Consortium (Commercial)	7,372
Rehabilitation/Improvement of ECG Dist. System	
IDA	5,222
IDA (To be negotiated)	1,730
Development of 33kv Sub-Transmission Systems	
IDA (To be negotiated)	678
ECG System Expansion Program	
IDA (To be negotiated)	1,202
ECG District Centres Rehabilitation	
IDA (To be negotiated)	276
Act of Distribution Network to Diesel Fed Locations	
IDA (To be negotiated)	1,156
Installation of a Supervisory Central and Data Acquistion SCADA)	
IDA	16

IDA (To be negotiated) ¢ 226

Commercial (To be negotiated) ¢ 226

Institutional Strengthening of ECG

IDA ¢ 2,095

IDA ¢ 1663

Building/Logistics Support for MFP

Lube Oil Blending Projects

ADB/Italian Government (To be negotiated) ¢ 2,441

Balance to complete funding required ¢ 1400

Bitumen Plant

(In Millions)
¢ 3,172 (F)
¢ 290 (L)
ODA & Italy Sources (TBS)

¢ 464 (L) - 290 (L) to be funded by contribution by local Oil Companies

Accra Second Bulk Supply Point

Korea (to be negotiated) ¢ 609 (F) = ¢ 110 (L)

GHANA ENERGY ASSESSMENT

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