THE GOVERNMENT OF ERITREA

MINISTRY OF ENERGY AND MINES

ASMARA POWER DISTRIBUTION AND RURAL ELECTRIFICATION PROJECT

Environmental and Social Assessment (ESA) Report Including Environmental and Social Management and Monitoring Plan (ESMMP)

January 2004

Executive Summary

Introduction

The Ministry of Energy and Mines of the State of Eritrea has requested the World Bank and other donors to finance the Asmara Power Distribution (Voltage Conversion and Rehabilitation) and Rural Electrification Project. IVO Power Engineering Limited of Finland and Electrowatt Engineering Ltd of Switzerland conducted the Feasibility Study in 1998. According to this study it was found that the present power distribution system in Asmara, which is 40-50 years old, is incapable of meeting additional loads, power failures and voltage fluctuations are frequent and losses are unacceptably high. Thus the main motive is to alleviate the acute weakness and shortcomings of the old distribution networks in Greater Asmara.

A latest estimate of the electrification level in rural Eritrea is 3% and the poverty level is around 70%. As modern energy and in particular electricity is a requirement to stimulate rural development and eradicate poverty, an intense government and donor support is required to change the way of life of the rural people and meet the Millennium Development Goals. This is the driving force behind the rural electrification component of the project.

The Ministry of Energy and Mines has requested the World Bank (WB) and other bilateral development partners to finance the project. It reached an understanding with the WB mission to take the responsibility to conduct an Environmental and Social Assessment of the proposed project, which is a requirement for appraisal. This report is an outcome of this exercise and has been carried out by complying fully with the Eritrean and World Bank standards for environmental and social impact assessment. It was agreed that the proposal components constitute a Category B project in terms of environmental impacts.

The report is produced in two volumes, the first being the main Environment and Social Assessment (ESA) Report that includes the Environmental Management and Monitoring Plan (ESMMP) and the second is the Resettlement Policy Framework (RPF).

Socio- economic, legal and administrative framework

Socio-economic Environment

Eritrea is a young country, which was liberated in May 1991 from Ethiopia after a thirty-year war of liberation. Two years later, a UN supervised referendum was conducted to ascertain the wish of the Eritrean people. In that referendum, 99.8% of the people voted for independence, and the Sate of Eritrea was officially proclaimed. It has a total land area of 124,320 km^2, and a marine exclusive economic zone of 121,000 km^2 along its 1200-km long coast line in the Red Sea, of which about 56,000 km^2 is territorial water over which the country exercises exclusive sovereignty. The country has also more than 350 small and medium sized islands. The resident population (i.e., excluding the Diaspora) of Eritrea was estimated to be around 3.2 million in 1999, and it is growing at a rate of 3.0% per annum. There are nine tribal groups in the country, namely Afar, Bilen, Hedareb, Kunama, Nara, Rashaida, Saho, Tigre, Tigrigna. Tigrigna and Arabic are the most frequently used languages for commercial and official transactions. English is widely spoken and used by government offices and is also the language used for middle, secondary and university education

In 1997, Eritrea registered the highest GDP and GNP since independence of 700 and 900 million US $ respectively. Per capita income is low averaging at 200 USD in the latter years.

Agriculture contributed about 16 percent of Eritrea's GDP in 1999, much less than most other African countries, while industry accounted for 27.3% and services 56.7%.

Administrative environment
The Government is headquartered in Asmara although efforts are being made to decentralise. For administrative purposes, the country is divided into six regions or Zobas, 57 sub-Zoba administrative districts, 701 administrative units, which on the average consists of 3-4 villages. There are 2606 villages in the country according to the 2001 report of the Ministry of Local Government. The administrative units are headed by elected officers from among the village communities.

Legislation of relevance to the project
The government's strong commitment to sustainable development is reflected by its ratification of the three most important environmental conventions, namely the UNFCCC, CBD and CCD and the follow-up activities in this line. Eritrea's strategy for sustainable development, of which environmental management is among its pillars, is encapsulated in several national documents. Eritrea is soon to proclaim an umbrella law on the environment. The Department of Environment of the Ministry of Land, Water and Environment is responsible for implementation of the national environment policies and programmes in collaboration with other relevant institutions. The main objective of the environmental policy is to harmonise sustainable economic growth and development with proper environmental protection and use. In March 1999, The Department of Environment launched the National Environmental Impact Assessment Guidelines and Procedures. These procedures lay out the general principles, approaches and instruments and the EIA licensing procedures. These guidelines are similar in content to the World Bank operational policies and guidelines on Environmental Impact Assessment.

The basic law governing land use is the Land Reform Proclamation of 1994, which vests ownership of land to the Government. This essentially mandates the Government to develop the principles and criteria for classifying land and planning for the various competing uses, such as use for agriculture, tourism, wildlife conservation, housing, public amenities, mining and so on.

An Electricity Proclamation has been prepared and submitted to the Government for approval. The purpose of the Proclamation is to promote efficiency, safety, environmental protection and the private sector involvement in the power sector. This Proclamation has provisions for rights and duties of licensees in the electricity business and users with respect to the use of land for electricity infrastructure in urban and rural areas. The Ministry of Energy and Mines has separate Directives on the procedures of cost sharing between Government and benefiting communities in rural electrification and on the role of electricity co-operatives.

With regard to electricity supply, the Department of Urban Planning standards and guidelines recognise the space requirements for the sources of electric supply and necessary premises for the network system and main power station and substations mandating the engineering design responsibility to the Eritrea Electric Authority. The Approach is similar to the other infrastructures like water, telecommunications and road networks.

Although, digitized map for all underground networks of water, electricity and telecom lines can not be secured as they are non-existent, information is available in maps for each specific area within Asmara.

Eritrea is blessed with perhaps 20,000 to 40,000 heritage sites, many of them having global, continental, and national importance. Many areas of the country can be considered extremely sensitive to development. Knowledge about the most sensitive zones is growing every day. However, many potentially sensitive areas are not yet known because archaeologists and heritage managers are only beginning to document the presence of cultural heritage sites.

Background to the Energy Sector

Biomass forms of energy are still the major sources in Eritrea. The energy balance for the year 2002 showed that **total primary energy supply** was around 787,730 tons of oil equivalent (toe), of which 499,750 toe, or 63.4%, was derived from local biomass fuels, and the remaining 287,980 toe, or 36.6%, from imported oil products. From the oil products, 59,160 toe was used for the thermal generation of 249.1 GWh of electricity at conversion efficiency of 38% from the public electric utility EEA systems alone. The **total final energy supply** was 702,360 toe, of which 66.8% was consumed by the household sector, 13.2% by transport, 10.1% by the public and commercial, 7.5% by the energy industry, and 2.4% by the manufacturing industry. The share of the electricity consumption was only 2.6%.

At national level, the 2002 Eritrean demographic and health Survey indicates that access to electricity for Asmara, other urban and rural areas are 99%, 61% and 3% respectively. Per capita electricity generation was 72.1 kWh while consumption was 60 kWh in 2002. In comparison, this shows nearly four-fold increase in the per capita electricity generation and consumption since 1991. There is about 600 kW solar PV system in the country, installed mostly for welfare focussed applications like water pumping, powering health centres, schools, communications, etc.

The Asmara Power Distribution and Rural Electrification Project

Distribution System in Asmara:

- Strengthen and make reliable the old substations at Asmara Centre, Gejjeret, Belesa, Denden, Tsada Kristian and Mai Nefhi by extending the new 66 kV transmission and installing new transformers;

- Convert the existing 5.5/.23 kV system to 15/0.4 kV system, i. e., voltage conversion by installation of underground cables and overhead lines, transformer cabins, transformer on poles, upgrading the switching and protection system etc.;

- Upgrade and modernise the existing low voltage distribution system which is outdated, very old and undersized to meet the electrical load requirement of Asmara City by installation of 40 km underground cable, 300 km aerial bundled conductors (ABC) and 100 km of open wire overhead system.

Rural Electrification of Keren, Barentu, Dekemhare and Adi Keih areas:

Design and manage the installation of low cost distribution systems including:

i) installation of 858 km 15 kV lines

ii) installation of 265 km of low voltage lines; and
iii) installation of 328 distribution transformers.

This system is expected to benefit close to 28,000 households, and over 1300 small industrial and commercial establishments.

Improving accounting practices and corporitization of EEA

- Prepare EEA to operate in the context of the Government's new power sector policy
- Improve accounting practices at EEA by hiring consultants (one financial management specialist and one IT specialist);
- Strengthen EEA's operational staff by training existing and new staff.

Description of the Baseline Environment

Physical environment

Eritrea is a land of great contrasts topographically; altitude ranges from 30m below sea level to 3018m above sea level. Four major physiographic regions can be identified: coastal plains, escarpment, highlands and western lowlands.

Geology: Eritrean geology is dominated by Precambrian rocks, also known as Basement Complex or crystalline rocks (formed more than 570 million years BP). Dominant rocks of this type are granite, schist and gneiss. Most of metallic minerals (gold, copper, zinc, lead, etc) are associated with them.

Rainfall, temperature and hydrology: Average rainfall in highlands is 450-600 mm per year, coastal Plains have less than 200 mm per year. Highest rainfall is in Northern part of Green Belt (Merara-Faghena area) where it reaches 900-1000 mm per year. Potential evapotranspiration is very high throughout Eritrea (1600 to over 2000 mm per year). Thus growing season is short (less than 45 days in Coastal areas to 90-120 days in highlands). Temperature are moderate in highlands (18-22^{0}C),but high in lowlands (> 30^{0}C) even though maximum temperatures could go over 40^{0}C in Coastal Plains. Eritrea is drought-prone country. Five major water basins: Setit, Gash-Mereb, Barka-Anseba, Red Sea, and Danakil. All rivers except Setit are seasonal. Underground water resource is little known, with boreholes yielding less than 5 litres per second.

Soils: There are eight major soil types in Eritrea covering 92% of the total area, of which most preferred ones for crop production by Eritrean farmers are Fluvisols, Luvisols, Vertisols, and Cambisols. Soil Erosion is a serious problem in Eritrea: up to 38 tons per hectare per year in some places.

Biological Environment:

Natural vegetation: Climax vegetation has been destroyed and replaced by shrub and grass vegetation. No complete inventory so far, but the Department of Environment has identified 24 vegetation types. Most forested area is the Green Belt. In areas of long settlement, evergreen shrubs various types of grasses are found. In the Western slopes, broad-leafed deciduous trees dominate.

Fauna: Study by the Department of Environment shows the existence of 130 species of mammals, 528 species of birds, 109 species of reptiles, and 10 species of amphibians. Some

animals have become extinct and some others are highly threatened. The Red Sea is rich in marine fauna, but it is particularly noted for its endemic species of coral genera.

Social Environment

Rural areas: In the socioeconomic survey conducted for this study, 100% of the respondents expect electrification to change completely to the better the quality of their life. About 96% think they can meet the costs of electrification. All of the respondents expect electricity will enhance their economic development effort, i.e., 40-95 percent of them expect production expansion, 43-63 percent plan to start new businesses, and 30-60 percent expect to employ more workers. Most of the people will use electricity for lighting and entertainment (radio, TV, tape recorder). In addition 51% will use it for cooking, 31% for other possible uses, 23% for income generating, and 13% for agricultural activities. Those willing to share electricity meters to reduce costs and those who want own meters are 51% and 29% respectively, the rest are undecided. With regard to participating in the co-operatives for the management of electricity services in the villages, the majority, 73 % are willing while another 14 % are not willing for various reasons. This is a very encouraging figure to the process of rural electrification. All the findings lead us to conclude that the rural electrification project in the study areas can succeed.

Annual Income and Expenditure of Households and Energy Expenditures

Income & expenditure	Dekemhare		Adi Keih		Keren		Barentu		Range
	Korbaria No. %	Gaden No. %	Quaatit No. %	Awhune No. %	Halhal No. %	HadishA No. %	Areda No. %	Mogolo No. %	
Income	7,875	6,533	3,967	2,119	4,328	4,500	8.186	19,285	2,119-19,285
Expenditure	5,338	4,052	4,329	3,357	4,864	4,898	3,902	5,893	3,902-5,703
Energy(HH)	885	1,688	444	210	760	431	385	767	210-1,688
Energy(Bus)	5,190	12,000	840	0	2,612	11,640	4,932	956	840-12,000

Households are spending between 10 to 20 percent of their income on energy needs (national average being 14%). We observe that households' yearly expenditure on energy ranges from Nakfa 210-1,688, while that of energy for businesses ranges from Nakfa 840-12,000.

Incomes in the capital Asmara, which averaged nearly 15,000 Nakfa, is twice as high when compared to the smaller highland and western lowland towns. Of those interviewees located in the part of Asmara where voltage conversion had been conducted, about 48% said they were notified before voltage conversion, while 36 percent say the opposite, 3% do not remember, and the remaining 13 % knew about it through personal inquiry. This could be a major cause for the damages reported on household equipment.

Potential Impacts and Mitigation Measures:

Asmara Power Distribution - Positive benefits

- Reduction of electrical losses by 9%
- Reduction in overall distribution operations and maintenance costs
- Global benefit by reducing CO_2 emissions
  - From Hirgigo Plant 45,000 tons/year
  - Asmara/Massawa technical loss reduction mitigates 21,000 tons/year
- Other secondary benefits
  - Better supply quality
  - Less disturbances and outages

- Voltage drops maintained at acceptable levels- more transformers close to each other and 3 times higher capacity
- Less connection costs (system upgrading not needed at least for 30 years)
- Reduction of visual intrusion by above ground distribution infrastructure

Rural Electrification - Positive Benefits

- Availability of the most preferred and versatile energy form, electricity, to motivate rural development
- Electric substitution to kerosene lighting - global benefit
- Electric substitution to diesel powered pumpsets/gensets -global benefit
- Removes energy related barrier to sustainable development/poverty reduction
- Rural people benefit from associated improved facilities:
  - Entertainment through TV and radio
  - Electronic communication services
  - Work burden reduction especially for women
  - Electricity-served self employment/income generation
  - Mushrooming SMEs and rural employment
  - Better health, school and water pumping facilities

  Etc…

Negative Impacts During the Construction Phase

The Asmara Power Distribution Project

- The project requires excessive excavation to lay underground MV & LV cables
- Temporary disturbance to urban car traffic, cyclists, pedestrians, businesses
- City roads could be dusty and dirty
- Unintentional damages to water and sewerage pipes, telecom cables
- Electromagnetic interference on telecom systems -
- Damages to buried heritage sites in Greater Asmara
- Power cuts to critical customers (hospitals, Gov't Offices, sensitive industries)
- Present radial structure distribution system will worsen power cuts

Mitigation measures in Asmara Power Distribution component

- The mitigation measures will be more streamlined and visible with the forthcoming detailed engineering design
- Urgency required in laying underground cables and refilling of the pathways
- In the absence of GIS paper maps of water supply and sewerage, telecom cables have to be utilised
- Follow Department of Infrastructure regulations to avoid damages
- Whenever electric and telecom cables meet, use perpendicular crossings with enhanced insulation
- Convert the radial to double-fed loop structure to avoid power cuts to all customers
- Use mobile diesel generators to supply critical customers and/or encourage them to have standby generators
- Other engineering design required e.g., to change the transformers (indoor or mast-mounted)
- Arrange different construction crews for MV and LV
- Prepare the users to shift to the voltage change

- Implement the RPF for the affected communities

Mitigation measures of negative impacts in rural areas

Negative Impact	Mitigation Measure
Damages to agricultural products	Erection during the dry season
The cutting of trees and branches	If unavoidable minimise
Securing an optimum right of way	Involve local administration and people
Access roads may pass through farmlands	Limit the use of heavy vehicles and pay compensation for damages
Some areas may be mined	Ensure mine clearance beforehand
Poverty related	Expand micro credits and income generating activities
Management related	Introduce energy service companies, EEA agents and/or Electricity Co-op in the villages

Analysis of Alternatives

There is no engineering related alternative to the upgrading needs of the Asmara Power Distribution (Rehabilitation and Voltage Conversion) project component apart from the choices of voltage levels, transformer sizes and conductor types and sizes.

Three phase 15-kV/0.4 voltage levels have been used for the supply of electricity to all near urban hitherto electrified rural areas. For villages located further away from the urban centres, other options of rural electrification could be considered for economic effectiveness, as the use of electricity for domestic purposes is likely to dominate. The rural electrification component of this project envisages exploring other innovative but cheaper options that may include (a) Phase to Phase, (b) Phase to Neutral and (c) Single-Phase-Earth-Return systems. The adoption of these systems depends on the soil situation of the area to be electrified and as such the soil condition of the areas have to be investigated by outside experts with experience in the field.

Environmental Management and Monitoring Plan

Concerning Asmara Power Distribution project

- The external engineering consultant should refine the division of labour between EEA and the local and foreign electrical contractors to be engaged;
- Ensure that the mitigation plans are sound in the engineering design;
- Other Gov't organisations have to be involved in the mitigation plans by forming technical committees;
- Implement the RPF whenever OP 4.12 is triggered through the preparation of Resettlement Plans (RP) defined in the RPF
- Secure enough budget and ensure the fast execution of the excavation and refilling of cable pathways;
- Prepare and motivate the customers to fulfil their obligations in converting 127/230 to 230/400 V systems
- Establish Project Management Unit from project funds
- Conduct Training for EEA employees

Concerning Rural Electrification

- On the role of EEA, foreign consultant, local subcontractors
- Fulfilling the condition that Barentu and Adi Keyieh be joined with the ICS

- Formation of Project Management Unit and support committee for RE
- Formation of Electricity Co-operatives and/or energy service companies to manage rural electricity services
- Implement the RP whenever OP 4.12 is triggered
- Enabling Village Administrations and service providers through training to conduct village level ESMMP and RPF especially in performing environmental and social screening
- Co-ordination with Zoba Village Administrations to ensure popular participation that includes initial payments for cost sharing and securing an optimum right of way
- Exploiting additional sources for helping the poor get electricity access
- Technical/financial assistance to promote shift from diesel powered pumpsets/gensets to electricity in rural areas
- Incorporation of village- and Zoba-driven initiatives from outside the targeted areas
- More areas will benefit from a feasible single-wire-earth-return system to be studied by a consultant from the project funds
- Promote meter sharing for domestic applications among neighbours to reduce costs
- Engaging the public, energy service companies and EEA agents in the management of electricity services in rural areas and conduct training to this effect.

Estimated costs for the ESMMP and RPF

Project activity	Estimated costs in USD
Establishment of PMU	238,400
Enabling DoE fulfil commitments in the project (training, monitoring and evaluation...)	50,000
Training for EEA employees	53,000
Training for VAs, ZAs and service providers	75,000
Cost of underground cable-way excavation and refilling	515,430
Implementing the RPF	50,000
Total	**981,830**

Note: The budget for training for EEA personnel is explicitly stated in the project document but not for the others, implying that additional budget is required.

Institutional arrangements for component I.
EEA engineering team and external engineering consultant in consultation with the WB will be responsible for refining the Project Document and producing a detailed engineering design for the project. EEA, a suitable external engineering contractor and local contractors will share the execution of the construction work. PMU in consultation with the stakeholders' technical committee will implement the ESMMP and RPF and follow-up the day to day activity of the project while the DoE will independently monitor the progress of the project.

Institutional arrangements for component II (RE).
EEA engineering team and an engineering consultant will study the suitability of cheaper options of RE, including single-wire-earth-return system. Based on the outcome, a RE design and selection of the optimum right of way will be conducted. Construction work will be shared between EEA and local private contractors. VAs and ZAs together with the PMU, DoE and RE support committee will collaborate to ensure popular participation and administering the ESMMP and RP. The DoE and the PMU will be the lead organs to conduct training to VAs, energy service providers and electrical practitioners.

List of Acronyms and Abbreviations

BP	Before Present
CBD	Conservation of Biological Diversity
CCD	Convention of Biological Diversity
DoE	Department of Energy
DUP	Department of Urban Planning
EEA	Eritrea Electric Authority
EIA	Environmental Impact Assessment
ESMMP	Environmental Management and Monitoring Plan
ERTC	Energy Research and Training Centre
ESA	Environment and Social Assessment
GDP, GNP	Gross Domestic Product, Gross National Product
GAR	Gross Attendance Ratio
GEF	Global Environment Facility
GPI	Gender Parity Index
ICS	Interconnected System
IEA	International Energy Agency
IGAD	Intergovernmental Authority for Development
ILO	International Labour Organisation
KGOE	Kilogram of Oil Equivalent
KWh/MWh/GWh	Kilowatt hour/ Mega Watt hour/ Giga Watt hour
LPG	Liquefied Petroleum Gas/Liquefied Propane Gas
MSMEs	Micro, Small and Medium Enterprises
MoA	Ministry of Agriculture
NGO	Non Governmental Organisation
OAU	Organisation of African Unity
PCE	Petroleum Corporation of Eritrea
PMU	Project Management Unit
RAP	Resettlement Action Plan
RETs	Renewable Energy Technologies
R & M	Repair and Maintenance
RPF	Resettlement Policy Framework
SCS	Self Contained System
TSE	Telecommunication Service of Eritrea
TOE	Tonnes of Oil Equivalent
UNDP	United Nations Development Programme
UNFCCC	UN Framework Convention for Climate Change
US$	United States Dollar
VA, ZA	Village, Zoba Administration

Exchange Rate:

One US$ = 7.2 Nakfa 1991-1997, 8.2 in 1998, 9.7 in 1999, 10.10 in 2000/2001 and 13.50 since September 2001.

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List of Tables and Figures

1. INTRODUCTION

1.1 The Project: Asmara Power Distribution and Rural Electrification

The Ministry of Energy and Mines of the State of Eritrea has requested the World Bank and other donors to finance the Asmara Power Distribution (Voltage Conversion and Rehabilitation) and Rural Electrification Project.

The main beneficiary of the Distribution Rehabilitation and Voltage Conversion component of the project is the capital city of Asmara and its surrounding satellite townships. IVO Power Engineering Limited of Finland and Electrowatt Engineering Ltd of Switzerland (IVO & EWE) conducted the Feasibility Study in 1998 and this was financed by the Government of Switzerland. This study has concluded that the present distribution system, which is 40-50 years old, is incapable of meeting additional loads, power failures and voltage fluctuations are frequent and losses are unacceptably high. The main objective of the project is thus to alleviate the acute weakness and shortcomings of the old distribution networks, and enable the adequate, reliable and sufficient electric power supply to domestic, commercial and industrial consumers.

The Rural Electrification component will focus on the local grid extension to villages surrounding the four major towns of Dekemhare Adi Keih, Keren and Barentu. The project will enable the construction of 860 km of 15 kV lines, 265km of low voltage lines with around 330 transformers. About 28,000 rural households and over 1300 rural industrial and commercial enterprises will benefit from the electricity connection.

1.2 Current power situation in Eritrea

Economic growth in many sectors of the economy has been constrained by inadequate and unreliable supply of power. The above stated feasibility study has concluded that businesses lost about 674 and 343 working hours in 1995 and 1996 respectively due to power cuts, load shedding and suppressed demand. This translates into a suppression of economic growth for the affected businesses of about 8% in 1995 and 4% in 1996.

In 2001, the total energy consumed in the country was estimated to be around 683,000 tons of oil equivalent, 66.7% of which was consumed by the household sector, 16.4% by the public and commercials, 14.1% by transport and 2.7% by industry. The share of oil products and electricity in the fuel mix of final energy consumed was respectively 32.9% and 2.4%; the balance of 64.7% being from biomass resources.

The Eritrea Electric Authority (EEA) had approximately 50 MW of diesel-fired generating firm capacity in 2001 excluding the new 84 MW Hirgigo power plant, which is now fully commissioned bringing the firm capacity to 134 MW. Around 21% of Eritreans have access to electricity, but only 2.8% of the rural population are now estimated to have the access. Averaged over the whole population, per capita electricity consumption has improved from as low as 16 kWh in 1991 to 63 kWh in 2002.

1.3 The Environmental and Social Assessment (ESA) Approach

The Ministry of Energy and Mines took the responsibility to undertake an environmental and social assessment of the proposed project. This has being carried out to comply fully with the Eritrean and World Bank standards since the proposals constitute a Category B project in terms of environmental impact. The Eritrean Environmental Impact Assessment procedures are detailed in the guidance prepared by the Department of the Environment. Reference is also made to the National Environment Management Plan, National Biodiversity and Combating Desertification Action Plans.

The World Bank requirements for safeguard policies that have been considered in this ESA report and the separate document, RPF, are the following:

- World Bank operational policies for Environmental Assessment (OP 4 .01)
- Bank Procedure (BP 4.01)
- World Bank OP 4.04 for Natural Habitats
- World Bank OP 4.11 for Cultural Properties
- Forestry Resources OP 4.36
- Involuntary Resettlement OP 4.12

The Department of Energy established a multi disciplinary Task Team entrusted with the preparation of the ESA report in February 2003 (See Appendix 11.1 for the list). The public consultations (See Appendix 11.2) relating to the ESA preparation commenced in March 2003. Numerous ideas and resource documents have been obtained through the consultation effort, which helped the ESA preparation immensely. The socio-economic assessment component of the ESA was tendered to local consultants and the successful bidder, Wekita Consultant, started fieldwork in May 2003. The main thrust of the fieldwork has been towards obtaining a full understanding of the socio-economic environment of the project areas. This consultant submitted to the Task Team its report on time for inclusion in the ESA report, which largely appears in Section 5.3. Simultaneously all aspects of the physical and biological environment have been examined in detail to establish pre-project conditions, assess the degree of impact and to design and plan the implementation and monitoring of mitigation measures. The Department of Geography of the University of Asmara is largely responsible for compiling these sections, i.e., Section 5.1 on Physical Environment and Section 5.2 on Biological Environment. The detailed ESA investigations were conducted in June/July of 2003. A stakeholders' workshop that was attended by 45 participants drawn from Government institutions and NGOs was arranged on August 1st, 2003 and recommendations have been incorporated in the report (see Appendix 11.7). The draft mitigation plans for the potential environmental impacts reflected in Chapter 6 where extensively discussed and enriched during the stakeholders' workshop.

Finally, taking the stakeholders' recommendations and commitments entered to collaborate in the project execution, the cornerstone of the ESA report, the Environmental and Social Management and Monitoring Plan (ESMMP) for the project, was compiled as it appears in Chapter 9.

A separate document that deals with the Resettlement Policy Framework (RPF) and the proposed Resettlement Action Plans (RAP) have been prepared following the standard format of similar projects in the country and elsewhere for projects that have the potential of

resettling people or negatively impacting their economic sources. The country's and the World Bank safeguarding policies are well reflected in this work.

1.4 The ESA Report

This Environmental and Social Assessment Report is prepared in two volumes. Volume I contains the report executive summary and the main ESA report with annexes and Volume II deals with the Resettlement Policy Framework (RPF). The report follows the normal format for such reports. Following this introduction, Chapter 2 deals with the legal and administrative framework, and Chapter 3 gives background to the energy sector. Chapter 4 describes the project and Chapter 5 the existing environment i.e. baseline conditions. Chapter 6 deals with the potential environmental impacts and Chapter 7 discusses mitigation measures. Chapter 8 develops the possible alternatives and Chapter 9 the environmental management and monitoring plan, which will run in conjunction with the execution of the project. Chapter 10 lists the references consulted in preparing the report. There are seven appendices to the main ESA report dealing with list of Task Team members, list of consulted people, urban planning checklist, cultural heritage sites in Eritrea, post electrification status of some villages, the Ministry Directives on Rural Electrification, stakeholders' workshop report, the environmental and social screening form and the sites of targeted villages for the Rural Electrification Component.

Volume II or the RPF has its own Executive Summary, introduction and 13 Sections elaborating the safeguard policies and the framework for resettlement plans for affected people.

2. SOCIO-ECONOMIC, LEGAL & ADMINISTRATIVE FRAMEWORK

2.1 Social Environment

Eritrea is a young country, which was liberated in May 1991 from Ethiopia after a thirty-year war of liberation. Two years later, a UN supervised referendum was conducted to ascertain the wish of the Eritrean people. In that referendum, 99.8% of the people voted for independence, and the Sate of Eritrea was officially proclaimed. Soon after, Eritrea was admitted to the UN, OAU and many other international organisations.

Eritrea has a total land area of 124,320 km^2, and a marine exclusive economic zone of 121,000 km^2 along its 1200-km long coast line in the Red Sea, of which about 56,000 km^2 is territorial water over which the country exercises exclusive sovereignty. The country has also more than 350 small and medium sized islands. According to the Common Country Assessment Report (UNDP, 2001) prepared by the Government and the UN Systems in Eritrea, from which most of the country specific information below is taken, the population of Eritrea was estimated to be around 3.2 million in 1999, and it is growing at a rate of 3.0% per annum. Asmara is the capital city of Eritrea with estimated population of 450,000. It is located on the on the central highland plateau at 2,400 meters (7000 feet) above sea level. Eritrea has two known ports Massawa and Assab located on the Red Sea.

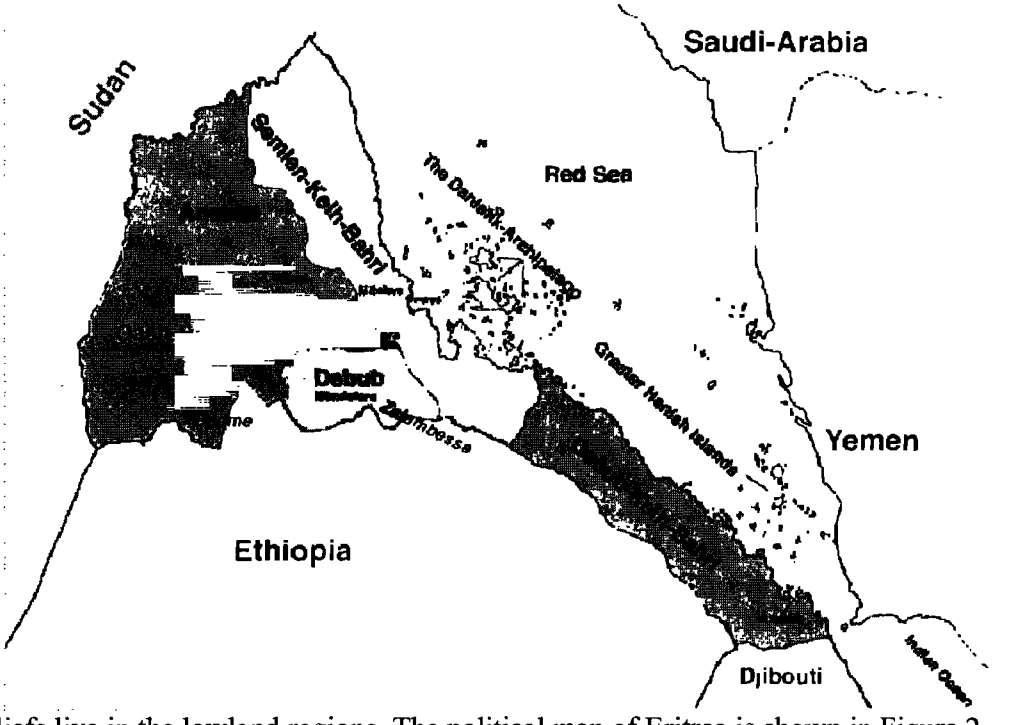
Official population figures for 1999 indicate that 80% live in rural areas and 20% in urban areas; this was revised in 2001 by the Ministry of Local Government to 62% rural and 38% urban (Eritrea Demographic and Health Survey, 2002). The large disparity with the previous figure is as a result of the redefining as urban some areas which where considered as rural by lowering the population lower limit to 5,000 residents having basic social services and local administration. The population under 15 constitutes 43% those aged 65 or more years is about 6%, implying a dependency ratio (ratio of active adults to children under 15 + old people) 1.04. The population distribution of Eritrea by regions, as extrapolated from figures provided by the Ministry of Local Government for 1996, is given in Table 2.1 below.

Table 2-1 Population of Eritrea, 1999 (See also the map below)

Administrative Region	Population	% of Total	Area, km^2	% of Total Area	Density people/km^2
Northern Red Sea	440,990	13.8	33,178	26.7	13.1
Southern Red Sea	297,502	9.3	23,384	18.8	12.7
Anseba	461,424	14.4	22,120	17.8	20.9
Gash Barka	629,116	19.7	34,529	27.8	18.0
Debub	774,455	24.2	9,709	7.8	79.8
Maekel	596,516	18.6	1,400	1.1	426.1
Total	3,200,003	100	124,320	100	25.7

Eritrea is composed of nine tribal groups, namely Afar, Bilen, Hedareb, Kunama, Nara, Rashaida, Saho, Tigre, Tigrigna. Tigrigna and Arabic are the most frequently used languages for commercial and official transactions. English is widely spoken and used by government offices and is also the language used for middle, secondary and university education.

Tigrigna and Tigre make up four-fifths of the population and both are related Semitic Languages. The Eritrean population is almost equally divided between Christian and Muslim. Most of the Christians live in the highlands, while Muslims and members of traditional



beliefs live in the lowland regions. The political map of Eritrea is shown in Figure 2.

Figure 2-1 Political map of Eritrea

In the 2002 Demographic and Health Survey, it was found that 50.2 percent of Eritrea's population were female and 49.8 percent male. About 45 percent of the population have never attended school, 29% have primary level, 9% middle, 14% secondary and 2% post secondary level qualifications. Females are more likely to be uneducated than males (52% and 38% respectively) and are also less likely to have attained each level of education especially the secondary level and above.

More than half of households (53.3%) in Eritrea were headed by males and 46.7% by females in 2002. The proportion of female-headed households were higher in Asmara and other urban areas (51 to 53 %) than in rural areas (43%). The national average household size lately stands at 4.8, which is slightly higher in rural areas than in urban areas.

45% of the Eritrean population are illiterate (52% for females and 38% for males). The latest figures for the Gross Attendance Ratios (GAR)[1] at primary level were 56.0% for males and 48.3% for females at the primary level. The corresponding figures for middle school were 78.6% and 60.4%, while those for secondary level were 50% and 35.3%. The GAR is higher than the Net Attendance Ratio as it includes participation of those who may be older or younger than the official age range for the level that are attending at that level. The Gender Parity Index (the ratio of GAR for males to that of females at a given education level) was 0.9

[1] GAR is defined as the total number of students in a school level as a percentage of the official school age population in that level

at primary, 0.8 at middle school and 0.7 at secondary school levels during 2002, indicating that fewer females are enrolled in school as the level of education rises. The female deficit observed in the middle and secondary school levels is partly due to young girls getting married and dropping out of school. The GPI index is much worse for the tertiary education level averaging around 0.1; here in addition to the above, domestic chores that focuses traditionally on young girls is also much to blame in lowering their educational performances at higher levels.

A rapid appraisal undertaken in 1993/94 by the World Bank, (1996) showed that about 69% of the population of Eritrea fell below the poverty level without considering food aid; with food aid 53% fell below the poverty level. The highest concentration of the poor, 83%, was found in the rural highlands, followed by the urban poor accounting for 62% and 52% in the rural lowlands.

The increasing pressure on the land resulting from population expansion, coupled with rural-urban migration have created severe resource constraints in the urban centres. In the urban areas, the existing utilities electricity, water and telecommunications have difficulties and limitations to cope with excessive demand. The Demographic and Health Survey of 1995 showed that that access to electricity in urban areas ranges from 97% in Asmara to 20% in Barentu (national average for urban areas 81%). Only 47% of Asmarans have piped water system into residence, 40% get water from tanker trucks and 12% from public tap. There are at present 40,000 telephone connections (exclusively in urban areas) while those on the waiting least are over 160,000. It is obvious that the existing utilities were largely planned and installed in the 1950s and 60s and were meant to serve the then far smaller urban population. Rural-urban migration has also had a serious impact on the rural areas. For instance, there is a sharp scarcity of active labour in the rural areas primarily caused by the declared 18-month youth service by the government and this has adversely affected production of food and other agricultural produce.

The Government of Eritrea's current drive is for rapid transformation of the physical infrastructures (roads, housing, energy, water supply and communications), the educational and health facilities, and to ensure food security by modernisation of agricultural practices mostly using the youth service and its own financial resources. Assistance from development partners has also been very instrumental but positive impact of foreign direct investment has not been very significant yet.

2.2 Economic Environment

In 1952, when Eritrea was federated with Ethiopia by decision of the UN against the wish of its people, its industrial production was greater than the industrial production of Ethiopia. In the early 70's Eritrea's industrial output from the 42 large and 650 small industries accounted for 40% of all industrial output in Ethiopia. In the 1950's and 60's, there were around 20,000 fishermen producing 25,000 tons of fish every year (Hadas Eritrea June 5, 2003). But at the time of liberation, the Eritrean economy was in shambles. Most of its industries had either been transferred to Ethiopia or rendered useless just to force the Eritrean people to migrate to Ethiopia in search of employment. Its basic social and physical infrastructure was also largely destroyed and/or neglected in the thirty-year war of liberation. At the time of liberation, it was estimated that the country needed two billion US Dollars to rehabilitate its economy, but the inflow of aid was very small, and the country had to rely largely on its resources to rebuild its economy.

Table 2-2 Summary of Economic indicators

	1994	1995	1996	1997	1998	1999	2000	2001
GDP at market prices (USD M)	510	574	631	655	650	650		
GNP per capita (USD)	180	180	200	230	200	200		
GDP growth (annual %)	9.8	2.9	6.8	7.9	3.9	0.8	-8.2	1.1
GDP Sectoral Shares								
- Agriculture	16.1	11.2	9.8	9.3	16.1	16.0		
- Industry		22.7	27.4	29.5	27.4	27.3		
- Services		66.1	62.8	61.2	56.5	56.7		
Inflation	6	6	6	6	9.0	11.2	26.8	15.0
Nominal exchange rate (Nakfa to USD)	7.2	7.2	7.2	7.2	8.0	8.8	10.1	13.5
Gross Domestic Investment (% GDP)	17.8	19.3	29.3	40.9	40.9	40.9		

Source: World Bank 2000, Macro Policy 2001

Agriculture contributed about 16 percent of Eritrea's GDP in 1999, much less than most other African countries, while industry accounted for 27.3% and services 56.7%. Nonetheless, some 60 percent of citizens depend on agriculture for all or part of their income and food and agriculture covers about 20-30% of the country's current merchandise exports (UNDP and MoA, 2002). Eritrea has an arable land of 2.1 million hectares, or 16.6% of its total land area, but only about 500,000 hectares, or 23% of the arable land, are currently under cultivation. Land productivity is still low, being less than 10 quintals (1 ton) per hectare for most crops.

In 1997, Eritrea had a GDP and GNP of 700 and 900 million US $ respectively; the difference was mainly made up of remittances by Eritrean nationals in the Diaspora. The industrial sector and service sector accounted respectively for 30% and 61% of the GDP, while the balance was accounted for by agriculture. In 1995, exports amounted to 30% of the GDP while imports amounted to 77% of the GDP (UN, Human Development Report, 1998:183). Eritrea's Gross Domestic Investment (GDI) is high by African Standard, amounting to 21% of the GDP. Its outstanding external debt in 1997, was 75.5 million US $, or 8.4% of its GNP.

Eritrea's economic development policy is anchored upon the establishment of a dynamic private sector-led, outward-looking market economy. The intention is to make the private sector the lead actor in the economic life of the country. The role of the government is limited to creating a conducive environment for development by maintaining law and order, sound macroeconomic policies, and by providing the social overhead capital (e. g., health facilities, schools, access roads, water, rural electrification) that are necessary to facilitate rural development.

2.3 Administrative Environment

The Government is headquartered in Asmara although efforts are being made to decentralise. The Ministry of Marine Resources is in Massawa and the Department of Defence in Beleza. For administrative purposes, the country is divided into six regions or Zobas, 57 sub-Zoba administrative districts that, under the decentralised system of governance, are responsible for the general administration of individual districts. The 57 Sub-Zoba Districts are further divided into 701 administrative units, which on the average consists of 3-4 villages. There are 2606 villages in the country according to the 2001 report of the Ministry of Local

Government. The decentralised system at administrative unit level is as of 2002 being administered by elected civil servants that are members of the village communities. Moreover, each administrative unit has a council whose members are elected and their role is to assist the elected administrators. To discuss and resolve on village specific matters, there is a 'Baito' or assembly in each village. The administrative role at the Sub-Zoba level is gradually being phased out.

The local administrative units and village councils are responsible for policies, resolving local conflicts and providing orderly leadership and democratic practices especially at the grass root level in their respective areas. This has facilitated mass participation and awakened the rural population to their rights and obligations, particularly with respect to involvement in development programmes and projects in their areas.

2.4 Legislation of Relevance to the Project

2.4.1 Environmental Management

The overriding objectives of the Government of Eritrea are to ensure food security for the whole population and the alleviation or eradication of poverty. The government has emphasised on many occasions that the proper conservation and sustainable use of natural resources are of paramount importance in achieving these objectives. The government's strong commitment to sustainable development is reflected by its ratification of the three most important environmental conventions, namely the UNFCCC, CBD and CCD and the follow-up activities in this line. Eritrea's strategy for sustainable development, of which environmental management is among its pillars, is encapsulated in several national documents, the prominent ones being, the: -

- Macro Policy (1994),
- National Environmental Management Plan (NEMP-E, 1995),
- Eritrean Constitution (1997),
- National Biodiversity Strategy and Action Plan (2000),
- National Action Program to Combat Desertification and Mitigate the Effects of Drought (2001), and
- Transitional Economic Growth and Poverty Reduction Strategy (2001-2005).

Eritrea is soon to proclaim an umbrella law on the environment. This Proclamation is expected to supersede all other laws on the environment, or related to the environment. The objectives of this Proclamation are to: -

a) establish the institutions responsible for integrating environmental protection and sustainable development in Eritrea and define their respective powers;
b) provide for implementation of the National Environment Management Plan for Eritrea (NEMP-E, 1995) as may be amended from time to time;
c) lay the foundation of environmental policy and law in Eritrea and provide the basic instruments for implementing, managing, monitoring and enforcing it;
d) provide for the co-ordination of environmental policies and their integration into macroeconomic development decisions; and

e) establish the basis for the State of Eritrea to make an effective contribution to international co-operation related to the environment and sustainable development.

The Department of Environment of the Ministry of Land, Water and Environment is responsible for implementation of the national environment policies and programmes in collaboration with other relevant institutions. The main objective of the environmental policy is to harmonise sustainable economic growth and development with proper environmental protection and use.

In March 1999, The Department of Environment launched the National Environmental Impact Assessment Guidelines and Procedures. These procedures lay out the general principles, approaches and instruments. Through the application of its procedures, it is intended to determine the potential negative environmental consequences of all infrastructure and natural resource development projects. The Minister of Land, Water and Environment has circulated a memo on 5/5/2003 to all potential proponents of such projects emphasising the obligations they have to strictly conduct EIA as per the Guidelines and Procedures.

2.4.2 EIA approval and licensing

The EIA process is identified as having three major stages - screening, the EIA and decision making. The screening process refers to the determination by the Department of Environment of which level of EIA is required for a particular project. The level of EIA process depends on the scale and possible effects of a project. If a project brief discloses significant impacts on the environment then a detailed EIA must be conducted. Following completion, the EIA is submitted to the department and on the basis of this report a decision is taken by the Director General to approve or reject the project. The third and final stage of the EIA process is decision-making. The decision making takes place after an exhaustive review process in which both Department of Environment and the developer consult all stakeholders. After the review process, the Director General of the Department of Environment can take any of these four decisions:

- may approve the project and issue a Certificate of Approval containing conditions that are legally binding on the developer;
- may require that the project be redesigned using other technology or an alternative site chosen;
- may refer back the project or part of it for other issues to be included;
- he may reject the project if mitigation measures for potential impacts are not appropriate.

A developer has the right to appeal to the High Court against the decision of the Executive Director within thirty (30) days. The regulations further prescribe offences for non-compliance with these requirements of law and also for the payment of fees by the developer for the processing of the EIA and monitoring of the project to ensure compliance with the conditions in the Certificate of Approval.

Licensing generally is the responsibility of the Ministry of Trade and Industry, which has the mandate to issue business license to investors. It does this through its Business Licensing Office. A business license means an agriculture, hunting and forestry license; a fishing

license; a manufacturing license; a mining and quarrying license; an electricity gas and water supply license; a construction license; a general trading license; a transport, storage and communication license; a financial intermediation license, a general service license; a professional service license etc. It therefore extends to all development activities with potential for environmental and social impact. Prior to issuing a business license an applicant must satisfy all other legal and administrative requirements, and obtain a clearance or permit from the sectoral regulatory bodies. For instance the applicant must comply with EIA requirements and obtain clearance from the Department of Environment before qualifying to obtain a business license at the last stage. However, lack of co-ordination among line Ministries and the overlapping of sectoral mandates with the Department of Environment is noted as a major concern by experts (Mumma, 2003) as the following example shows.

A Business license is required to support an application to the Department of Land for an allocation of land on which to undertake the business activity in question. Therefore, the EIA clearance has to be given to support the application for a business license *before* the 'full EIA' can be conducted. It is only after that the land is allocated for the business. This implies that the 'full EIA' is in effect undertaken without knowing the actual physical location of the business. This can reduce the EIA to a mere *pro forma* exercise. To make the EIA process effective, land allocation should precede the EIA clearance and this in turn should be the last stage before licensing.

2.4.3 Land Use Planning

In the National Action Plan on Desertification, combating land degradation is a key policy priority for Eritrea, whose successful implementation requires a multi faceted and cross-sectoral approach. The basic law governing land use is the Land Reform Proclamation[2]. This Proclamation vests ownership of land in the Government. Eritreans above 18 years of age have the right to be allocated land for use (e. g., at least 2 hectares each for agriculture purposes), subject to meeting of the criteria set out in the Regulation on the Distribution and Administration of Land (Legal Notice No 31 of 1997). This Regulation states that the government shall have the supreme authority to formulate the country's land use policy and to determine the classification of land and land use planning. This essentially mandates the Government to develop the principles and criteria for classifying land and planning for the various competing uses, such as use for agriculture, tourism, wildlife conservation, housing, public amenities, mining and so on.

Sectoral policies across the board have implications for land use and land management. Agriculture policy calls for the creation of a modern, technologically advanced and competitive agricultural sector and the development of irrigation. Water policy requires the promulgation and enforcement of a comprehensive water law and equity in allocating water between competing uses. The relevant energy and mining policy is to assess and develop energy and mineral resources to the best interest of the people and the economy, while the policy on biodiversity calls for the creation of a system of protected areas. On forestry the policy is to promote afforestation, rehabilitation of catchments and the development of agro-forestry. These sectoral land use policies are simultaneously development and conservation

[2] Proclamation No 58/1994: A Proclamation to reform the systems of land tenure in Eritrea, to determine the manner of expropriating land for purposes of development and national reconstruction and to determine the powers and duties of the department of Land.

oriented and may at times create conflicts of interest among the sectors themselves and between the sectors and the Department of Environment.

2.4.4 Biodiversity Conservation

Biodiversity conservation refers to the management of flora and fauna that is plant and animal life. A key mechanism for the management of biodiversity is the designation and maintenance of a system of protected areas, in order to protect particular threatened habitats. The Ministry of Agriculture has the mandate to manage forestry as well as wildlife, and it does so through two distinct units under the Forestry and Wild Life Division. The Division is responsible for afforestation programmes and large proportions of its activities are geared towards tree planting for water and soil conservation. The primary strategy for natural forest conservation has been to declare a certain woodlands and forest areas as a "closure" to human use; to date over 200,000 ha has been designated as a closure. This is done under customary laws, as Eritrea presently does not have a legal framework for designating protected areas. The Wildlife Unit also would like to establish protected areas in the Buri Peninsula and in Gash Barka (may include some of the project sites in Barentu area), as a priority.

According to Mumma (2002), the Ministry of Agriculture has prepared a draft Proclamation on the Conservation of Forestry and Wildlife. This would empower the Ministry to establish a system of protected areas. The draft does not however indicate the functions, jurisdiction, powers and duties of the Ministry of agriculture in protected area management, the categories of protected area, and the relationship between the Ministry's powers and those of other institutions with a regulatory mandate over protected areas. Further these functions are likely to overlap with the functions assigned to the Directorate of Eritrean Cultural Heritage by the Draft Proclamation for the Protection and Conservation of the Heritage of Eritrea, 1995, a work supported by UNESCO. Under Article 9(1) the Directorate may designate a conservation area on the ground of historic, aesthetic or scientific interest. Moreover, the Directorate may introduce a system of site management by regulating the conditions of a protected area of a cultural heritage, in accordance with the best environmental, ecological, scientific and educational principles. No provision exists in either draft for resolving duplication and possible conflicts of mandate. It is also observed that the draft Environment Proclamation also mandates the Department of Environment to administer a system of protected areas. It is also possible that a site declared as a protected are may have huge potential for the development of irrigated or tourism, and might attract investors interested either in irrigation or in developing tourist resorts. The land use planning process may earmark it for either development of agriculture or for conservation, depending on the objective sought to be achieved by the land use plan. There is thus a strong case for establishing by law a mechanism for coordination of environmental regulation.

2.4.5 Regulations in the Energy Sector in Eritrea

Matters pertaining to electricity in Eritrea are at the moment being governed by Electricity Board Chaired by the Minister of Energy and Mines. Moreover, an Electricity Proclamation has been prepared and submitted to the Government for approval. The purpose of the Proclamation is to promote efficiency, safety, environmental protection and the private sector involvement in the power sector. The Proclamation makes provisions for the establishment of a National Electricity Regulatory Board. This will be an autonomous body that will enforce

the Proclamation and associated Regulations and Directives with respect to the commercial and safety aspects of the electricity business as well as the functions of generation, transmission, distribution and supply of electricity. All licensees are required to comply with all possible safety, health and environmental laws of Eritrea.

The Asmara Power Distribution and Rural Electrification project will require power lines which will cross various types of land cover and may result: - in the loss of forests and agricultural products and cultural heritages; in redesigning of motor ways, roads and other construction; and may cause degradation of bio-diversity and soil erosion among other effects. This shall be analysed further in the chapter on potential impacts.

Chapter 3 of the Electricity Proclamation deals with the interface of electrical infrastructure with town plans and constructions. Article 13 stipulates that any licensee shall have the right to enter land or premises in the holding of any person in the area covered by the license and carry out activities necessary to undertake electricity operations including cutting of trees and vegetation if they interfere with the construction, erection and maintenance of electrical lines. Article 16 states that any master plan of a town shall demarcate and show the electrical supply system layout and that licensees should comply with it. It further points out that if any change or modification in the town necessitates displacement of existing electrical installations that were erected in compliance with the town plan before the change, the body authorising such a change in the town plan shall compensate the licensee for the cost subsequently incurred. Article 17 states that no construction, farming, plantation or any other activity of a permanent nature may be carried out within the clearance zone adjacent to electric transmission stations or lines. Moreover, this Article has the following two relevant components. If a new road or other construction structure makes it necessary to make changes in existing electrical installations, the owner of the new road or construction shall compensate the licensee for the consequent cost. If the construction of new electrical installations makes it necessary to make changes in already existing constructions, the licensee shall compensate the owner of the construction for subsequent cost; this empowers the Electric Authority at cost to break up any soils and pavement of roads when constructing and erecting electric lines. Article 18 on liability and compensation for damages states that the licensee shall pay compensation for damages caused to the property of a land holder after entering his/her premises for electrical operations.

Ministry Directives with respect to Rural Electrification. The Ministry of Energy and Mines has issued the 'Directive No 001/2001 - On Procedures of Computation of Cost of Electric Line Connection and Billing in Rural Areas and Suburbia' in December 4th 2001 which became operative immediately after. The purpose of this Directive is to provide standardised procedures that shall serve as a basis of computation of connection costs in rural and semi-urban areas as well as to pave the way for community participation in the management of electricity supply, billing and collecting. The content of this Directive is available in Appendix D.

Article 24 of the Draft Electricity Proclamation gives provision for the establishment of Rural Electrification Fund. It authorises the Minister of Energy and Mines to declare a levy of upto 3% on all electricity consumed. This fund shall be used to support electrification (from the grid or from stand alone or hybridised renewable energy technologies) of rural areas and other areas considered economically nonviable for electrification by licensees. The fund in addition to receiving the proceeds of the electricity levy of this Article may also benefit from

Government budget support, contribution from beneficiaries and from donations and loans by local and external institutions.

2.4.6 Regulations pertaining to urban planning

The general objective of urban planning is the promotion of a safe, healthy and pleasant environment and the improvement of quality of life. The fulfilment of such stated goals entails the proper utilization of land and natural resources, the formulation of policies that will enhance and strengthen the socio-economic bases of cities and towns and the application of rational land uses.

With ultimate goals and objectives to address all aspects of the physical, social and economic developments, the planning document of the Department of Urban Planning (DUP, 1998) is an important guideline for implementation of development infrastructures. The standards and guidelines include sufficiently detailed illustration of proposed physical and social development of an urban setting or region to arrive at the desired goals. The primary data requirements for urban planning are given in Appendix A.

Asmara, a city known for its modern town structure, is at present greatly in need of hard working and cooperation among its institutions involved in infrastructural networks of services to coup with the demands of modern urban settings. Lack of up-to-date and precise information on its physical infrastructures, in addition to lack of integrated planning and implementation of rehabilitation, expansion and new projects has made costs more and services frequently interrupted. It is clearly understood that new urban planning that aims at securing an acceptable blend of conservation and exploitation of land as the background or stage is much more easier than reshaping existing cities or towns into modern settlements with all the requirements of modern urban planning.

According to the DUP, many elements that form the basis of information for urban development must be set in preparation for planning. The nature, scale and form of the environment must be well studied. A knowledge and record of the topography, geology, climate, materials, areas of special interest like cultural heritages, location of rich agricultural land and sources of pollution are prime requirements of the land use plan. This information enables to construct land use maps and the potential direction of future development.

Infrastructural decision-making will best serve if related issues of concerned institutions are included in the planning process. In order to avoid power interruptions and to minimise conflicts or confusion with the interests of DUP during and after implementation, the socio-economic & environmental impact assessment of "Asmara power distribution project component" has thoroughly referenced the urban development standards and guidelines.

In response to the requirements by the DUP, that the plan must first layout the physical infrastructures, the study has addressed the importance of all relevant information regarding the physical features of existing Asmara and the future greater Asmara area. These applies to the power distribution systems, water supply piping systems, sewerage lines of urban liquid waste and for rain water run-off, telephone lines reticulation system and institutions and public services sensitive to power cuts, etc...

With regard to electricity supply, the DUP standards and guidelines have clearly put that, in urban planning a preliminary study on the sources of electric supply and necessary premises for the network system and main power station and substations should be done. However, the urban planner is not supposed to make any design works for the above-mentioned services other than reserving sufficient space for the services while preparing the plan. Therefore, during planning, even if immediate services of such kind are not ripe because of financial reasons, space provisions for future expansion or rehabilitation is usually taken into consideration. The document has also incorporated planning statements on the need of electricity infrastructure for industrial areas, whose demand for power depends upon the type of industries.

Although not yet decreed as a rule, the Department of Infrastructure of the Municipality of Asmara has already developed a linear relationship on the layout of distribution network among the EEA, TSE, water, and trees lining, which depends on the size of the sidewalks/pavements in the streets of Asmara. The layout is implicitly considered as a working tool among the concerned parties and is applicable in areas where new development is undergoing, and serves as a reference whenever confusion on layouts appeared. This *de facto* guideline for distribution facilities and picturesque representation is provided in the Figure 2 below.

It is pity that the Task Team could not secure a digitised map of all underground networks of water, electricity and telecom lines, as they are non-existent. The information appears in large maps and for each of the specific area within Asmara.

Table 2-3 Proposal of Distribution Utilities in Asmara

Space Allocated in Centimetres						
CLEARANCE FROM WALL	T.S.E	WATER & SEWER	TREES & BUSHES	E.E.A & ST. LIGHT	CURB STONE	SIZE OF S-WALK
20	40	40	.....	50	.....	150
20	60	50	.....	50	20	200
20	50	50	.....	60	20	200
30	80	60	.....	60	20	250
30	60	60	.....	80	20	250
30	80	60	50	60	20	300
30	60	60	50	80	20	300
30	100	80	60	60	20	350
30	60	80	60	100	20	350
30	120	120	70	60	20	400
30	60	120	70	120	20	400

NOTE:

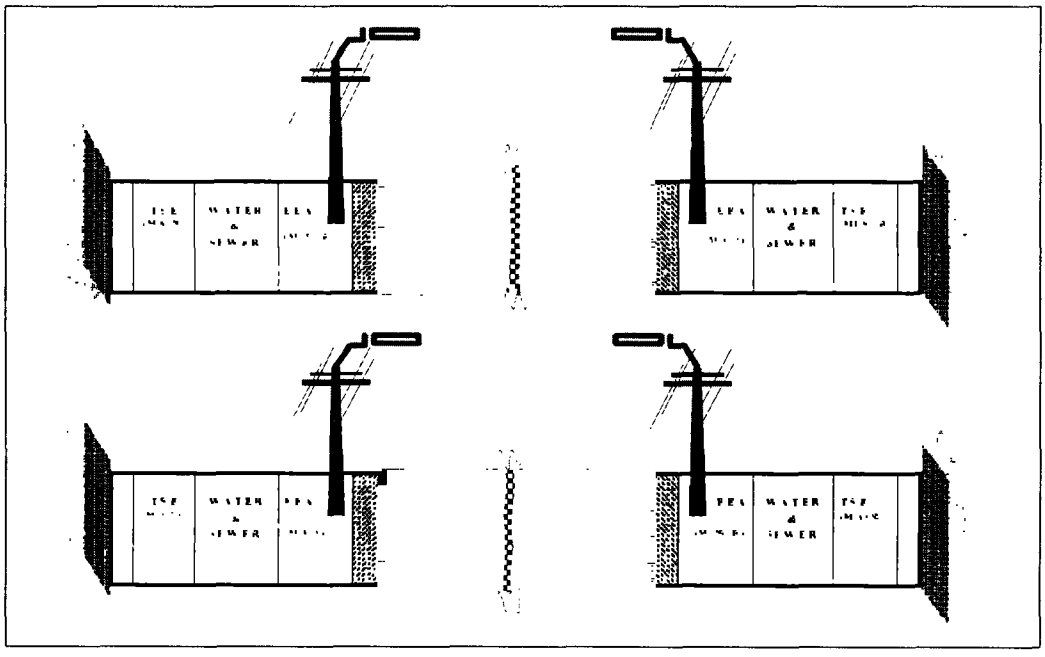
1. Telephone lines and electric lines are to be buried alternatively. When the main electric lines is on the right side of the road, the main telephone line will be on the left side of the road to avoid electromagnetic interference. The main lines take the larger space size from the given option.
2. The space allocated for water supply and sewer is not clearly delineated. If there is a problem of space grade separation can be made.
3. Storm sewer is assumed to be on the gutter of the road.

No veranda, balcony or the like shall be erected or re-erected or any addition or alterations made to a building within the distance quoted below from electric lines.

Voltage specification

Voltage	Vertically (m)	Horizontally (m)
A) Low and medium voltage	2.5	1.5
B) High voltage limits up to 33,000V	4.0	2.0
C) High voltage above 33,000V	4.0 +0.5m/33,000V	2.0+0.5m/33,000V

FOR 200 - 250 WIDE S - WALK



FOR 300 , 350 – 400 WIDE S - WALK

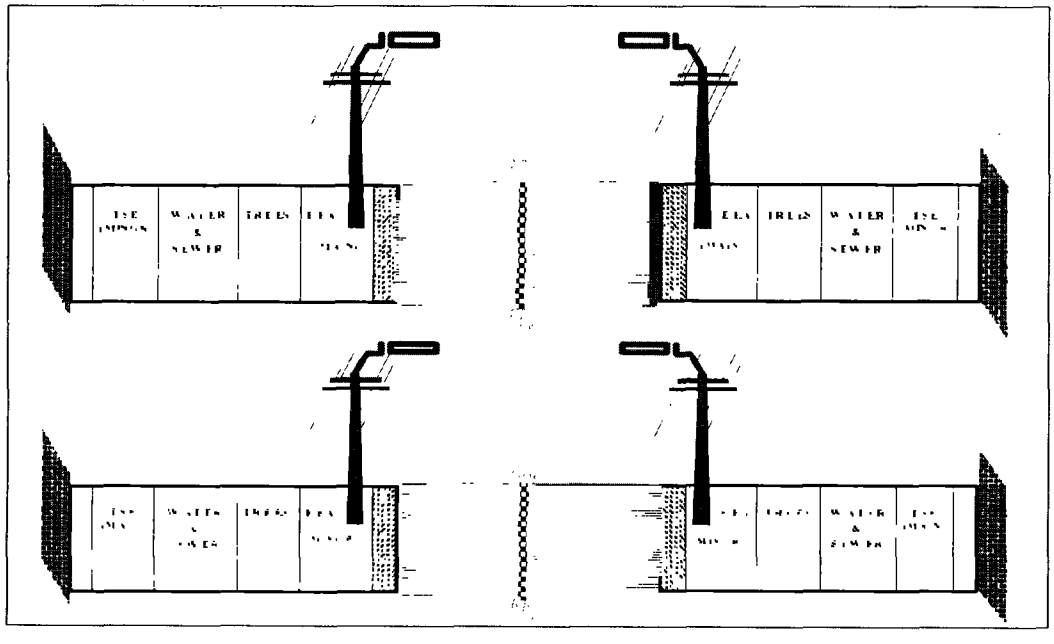


Figure 2 de facto guideline for distribution facilities and picturesque Representation

2.4.7 **Areas of cultural Heritage Potential** (source: The National Museum)

Eritrea is blessed with perhaps 20,000 to 40,000 heritage sites, many of them having global, continental, and national importance. Many areas of the country can be considered extremely sensitive to development. Knowledge about the most sensitive zones is growing every day. However, many potentially sensitive areas are not yet known because archaeologists and heritage managers are only beginning to document the presence of cultural heritage sites. This means that any development may result in a negative environmental impact on heritage resources if the national museum is not first contacted. Once contacted, museum and university personnel will make a rapid assessment survey to clear the area for development or to work with planners in suggesting mitigating alternatives to activities that will result in the destruction of cultural heritage sites. The following are considered sensitive areas:

- Areas of high sensitivity include historic places registered with the National Museum, as well as those not registered with the National Museum but known to local communities or residents. Such known places include sites such as the Nakfa trenches, Adi Shreem, Adulis, and underwater wrecks. Any structure built in a traditional architectural style may also qualify as a potentially historic place, depending on its particular history.

- Areas of sensitivity include religious places such as Debre Bizen, Debre Libanos (Hamasien); Debre Sina; Mariam Dearit, Sheikh Al Amin (Bet Ghiorghis), Sheikh Seid (Emberemi, Wekiro), and many others not mentioned here. Traditional religious shrines used by non-Christian and non- Muslim peoples are considered as sensitive as those mentioned above.

- Areas of sensitivity include more recent historical places, which have figured critically in the formation of the national identity: Nakfa, Himbol, Arareb, Amberbeb, Halibet, Tsabra, Embalqa, Arag (wina).

- Areas of very high sensitivity include archaeological sites and monuments, most of which are not yet registered with the national Museum, requiring caution in identifying potential sites that may be endangered. Since sites registered with the National Museum form a very small portion of Eritrea's cultural heritage, any listing of sensitive areas is incomplete and potentially misleading. To guard against inadvertent loss of priceless and irreplaceable cultural heritage, the National Museum must be asked to survey or assess areas for development in the following very sensitive zones:

- Greater Asmara, particularly the peri-urban area. Heritage surveys show the following areas to be of very high sensitivity: Sembel, Kushet, Akria, Mai Tchuhot, Amba Galiano, Qahawta, Biet Ghiorgis, Godeif, etc. No category A, B, or C development in Kushet should occur without an initial survey to confirm the absence or presence of cultural sites.

- Adi Keyieh, Senafe, Tekonda, Qohaito plateau, Dahlak Kebir, Metara, Adulis, Foro, Zula: All are extremely sensitive regions and current town and village expansions are negatively impacting both known heritage sites and many others just recently documented.

- Greater Keren, Mendefera, Massawa—all of these urban areas are known to be surrounded by archaeological sites, most of which have not yet been assessed in detail.

- All settlements greater than 400 people in the highlands between Dekemhare and the Ethiopian border should be considered within a sensitive heritage region. Around 70 villages earmarked for electrification in these project lie in this culturally sensitive region. The known sites are provided in Appendix B.

- All areas along natural waterways—where prehistoric and historic communities settled should be considered sensitive for cultural heritage.

3. Background to the Energy Sector in Eritrea

Biomass forms of energy are still the major sources in Eritrea. The energy balance for the year 2002 showed that **total primary energy supply** was around 787,730 tons of oil equivalent (toe), of which 499,750 toe, or 63.4%, was derived from local biomass fuels, and the remaining 287,980 toe, or 36.6%, from imported oil products. From the oil products, 59,160 toe was used for the thermal generation of 249.1 GWh of electricity at conversion efficiency of 38% form the public electric utility EEA systems alone. The **total final energy supply** was 702,360 toe, of which 66.8% was consumed by the household sector, 13.2% by transport, 10.1% by the public and commercial, 7.5% by the energy industry, and 2.4% by the manufacturing industry. The share of the electricity consumption was only 2.6%, that of oil products 32.5% and the balance, or 64.9% was derived from biomass.

Energy consumption in households was 93.6% biomass based, 5% from oil products and only 1.4% from electricity. At national level, approximately 24% of the Eritrean population have access to electricity. The corresponding access figures for the urban, semi-urban and rural population are estimated at 86%, 49% and 2.8%. Per capita electricity generation was 72.1 kWh while consumption was 60 kWh in 2002. In comparison, this shows nearly four-fold increase in the per capita electricity generation and consumption since 1991. There is about 600 kW solar PV system in the country, installed mostly for welfare focussed applications like water pumping, powering health centres, schools, communications, etc.

The temporal total energy consumption pattern shows some interesting trends both in the relative share of biomass and modern energy as well in the mix of the biomass sources. According to the energy surveys conducted by the Ministry in 1995 and 1998, the share of biomass fell from 79% in 1995 to 66% in 1998 (see Table 3.1). The decrease may be attributed to the following reasons:

- The fuelwood consumption per capita of 440 kg as estimated from the 1995 survey looks exaggerated for most households. The 1998 survey result of 250 kg /capita/year or around 115 kg/household/month is more realistic to the majority of households. This also applies to dung and charcoal.

- The introduction of regulations that ban the cutting of live trees for fuel and charcoal making, and growing area coverage of closures restrains access to fuelwood. The cited regulations have been dictated by the unsustainable rate of harvest, which stood in 1995 at 2.4%-2.8% of the stock. This rate of harvest is almost twice the critical threshold of 1.25% recommended for sustainable harvest in the semi-arid regions of sub-Saharan Africa.

- These conditions have led to shifts to other sources of energy, mainly kerosene and agri-residue for cooking, and energy-saving practices by users.

Table 3-1 Biomass Energy Consumption 1994-2000 (000 tons).

Type of Fuel	1994	1995	1996	1997	1998	1999	2000	2001	2002
Fuelwood	1,292.4	1,334.1	1,375.2	1,418.2	830.7	855.6	881.2	1022.8	1054.2
Charcoal	113.8	117.4	121.1	124.8	73.3	75.5	77.8	80.0	82.5
Dung	360.0	371.3	382.7	394.4	265.4	273.3	281.5	316.6	326.1
Agri-residue	47.2	48.8	50.3	51.9	90.8	93.5	96.3	98.5	101.4

After biomass, oil products constitute the second important source of energy in the country. The consumption of oil products increased at an average of about 10% per annum between 1993 and 1997 as shown in Table 3.2. In 1998, the consumption was lower than that of 1997 mostly due to decrease in diesel and bunker fuel consumption after Ethiopia's boycott of the use of the Eritrean ports.

Table 3-2 Consumption of Petroleum Products by Fuel Type and Year ('000' Tons)

Fuel Type	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Petrol	6.10	10.37	11.78	12.60	14.03	14.73	16.03	16.25	14.42	17.19	18.14
Diesel	55.69	102.85	114.37	128.8	134.15	137.73	103.54	113.86	110.52	116.03	115.53
Kerosene	8.15	12.27	14.18	17.24	19.72	21.09	21.19	22.5	21.25	22.37	20.37
Jet Fuel	3.53	3.89	4.21	5.41	9.61	9.86	6.87	7.6	9.23	11.00	8.32
LPG	0.30	0.43	0.83	1.25	1.31	1.50	0.82	1.32	1.67	3.05	3.51
L. Fuel Oil	11.72	23.62	26.40	34.83	45.06	43.16	41.52	40.97	42.95	40.62	20.73
H. Fuel Oil	0	0	0	0	0	0	0	0	0	8.00	35.77
Others*	3.64	15.16	13.18	12.8	8.63	17.21	6.4	5.63	4.87	5.93	6.84
Total	**89.13**	**168.59**	**184.95**	**212.92**	**232.51**	**245.28**	**196.37**	**208.13**	**204.91**	**216.19**	**229.21**

* Others refer to lubricant and bitumen

The introduction of modern energy services in Eritrea dates back to the Italian period. It is possible that electricity and fossil fuels may have been introduced to Eritrea at the beginning of the 20th century, but the actual production and sales of electric energy commenced in 1920 by Azienda, an institution owned by the then Italian government. The supply of electricity at that time was mainly restricted to Asmara and Massawa. Sixteen years later, two private Italian companies, namely SEDAO and CONNIEL, took over the production and sales of electricity. SEDAO owned and managed electricity business in the Asmara-Massawa line, and hence, laid the foundation for the present day Interconnected System (ICS), while CONNIEL operated in the other towns like Mendefera, Keren, Assab, Dekemhare, etc., which forms the present day Self-contained System (SCS). SEDAO also operated a small hydroelectric power at Durfo driven by water pumped from a small water reservoir at Beleza. In 1964 and 1968, two steam turbines with a combined capacity of 15 MW were commissioned, and the reservoir was used to supply water to these turbines. The steam turbines were decommissioned in 1993 as a result of old-age induced wear and tear and the fact that the frequent draughts of the 19970s and 80s made the reservoir unable to store enough water for their steady and reliable operation. At present the reservoir is used as a coolant for the thermal generators erected there.

The total firm generating capacity of electricity at present is over 160 MW of which the national utility, the EEA, accounts for around 134 MW while the remaining comes from either public institutions like Assab Petroleum Refinery, Assab Port Administration, small municipalities in remoter towns, or private entrepreneurs with smaller gensets. Table 3.3 shows an average growth rate of 8.4% per annum for the generation of electricity from the EEA systems alone while consumption increased by 9.2% annually. Although a slight decrease in the number of customers was registered for 1993, probably as a result of the Ethiopian population that left after independence, there was an increase of about 5,500 of new customers every year between 1993 and 1997, but slowed down substantially in 1998-2000, indicating a low connection rate; this has improved significantly since 2001. The EEA firm capacity that stood at around 26 MW in 1991 was more than doubled by 1996, but showed little change in the years that followed. With the commissioning of the Hirgigo

Power and Transmission Expansion Project, the EEA firm capacity has increased by 84 MW, bringing the total firm capacity of EEA to 134 MW.

In 2002 out of the total 213.73 GWh power consumption from EEA systems, 36.5% was consumed by the household sector, 29.1% by the public and commercial, 28.5% by manufacturing industry, and 6% by the energy industry itself. In 2001, the respective consumption shares were 36%, 27.3%, 31.7% 5.1% implying that industrial activities have slowed down. The peak load in the ICS rose from 27.53 MW in 1996 to 44 MW in 2001. Yet of the total generated power in the country from the EEA systems, 80% is consumed in the areas covered by the ICS, with Asmara alone accounting for about 2/3. These facts are indications and direct manifestations of the low level of development of the Eritrean economy and the unequitable distribution of the power supply system in the country. However, the steady growth of the power supply and per-capita consumption that has been witnessed in the last nine years is a manifestation of the post-liberation development trend in Eritrea.

Table 3-3 Profile of Electricity from the EEA Systems, 1992-2000.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Generation, GWh	119.9	130.2	144.7	161	180	186	205	201.4	224.44	249.1
Consumpt., GWh	93.4	105.8	123.2	127.6	143.7	145.2	158.5	159.7	185.7	206.1
Loss, %	22.1	18.7	14.9	20.7	20.2	21.1	22.7	20.7	17.3	17.5
No. of Customers	68,902	74,439	78,000	85,250	91,096	94,380	95,695	96,186	102,424	103,169
FirmCapacity, MW	40.8	39.1	55.7	56.8	54.4	54.2	53.8	49.8	134	134
Per Capita, kWh	35	38.4	43.5	43.7	48	46.8	48	47.2	59	60
Population, 10^6	2.67	2.75	2.83	2.92	3.01	3.1	3.19	3.29	3.38	3.59

Besides the national effort to develop conventional power generation and supply systems, due attention has been given to the introduction and development of renewable energy technologies. Although in the future the prospect could be good, the contribution of non-biomass renewable energy resources has so far been negligible in the national energy balance.

Summary of Achievements in the energy sector, 1991-2002:

The major achievements made in the energy sector since the liberation of the country in May 1991 include the following: -

- The electricity generation capacity of the Eritrea Electric Authority (EEA) has been increased from as low as 35 MW in 1991 to over 70 MW by the end of 1995. Consequently, the per-capita electricity consumption grew from as low as 16 kWh in 1991 to 48 kWh by 1997. A number of villages around our major towns got access to electricity;

- A major project for power generation and transmission expansion has now been commissioned in March 2003. This project, besides providing an 84 MW additional generating capacity, a 70 km of 132 kV and 150 km of 66 kV transmission lines, has enabled the inclusion of seven major towns and several rural communities into the integrated grid system;

- To make the power systems more efficient and to promote energy conservation measures, feasibility studies of major projects to rehabilitate the old transmission and distribution systems in Asmara and Massawa have been finalized. The Massawa project is in the implementation process while that of Asmara (the Asmara Power Distribution component

of this project) is expected to commence in 2004 with financing from the World Bank and other development partners.

- To diversify the sources of energy supply:-
    - national wind and solar energy assessment study has been conducted;
    - pre-feasibility study for geothermal energy potential has been conducted;
    - to tackle the prevalent household energy problems, a programme to disseminate improved traditional wood-stoves has been launched and the supply and distribution of kerosene and LPG has been expanded;
    - a feasibility study of wind energy applications has been finalized for the southern coastal areas of Eritrea. A 4 million US $ project document for wind park to feed the Assab grid and many decentralized stand alone or wind –hybrid systems in the small towns and villages in the area has been prepared. GEF has pledged to cover 50% of this and the Government and the private sector are expected to cover the rest.

- Petroleum law and regulations has been promulgated and three concessions for oil prospecting awarded to a consortium of foreign private companies;

- Negotiation is going on to revitalize and expand the Assab Refinery with interested private companies;

- Formulation of new energy laws, regulations and standards is now finalised and is expected to become public soon. The intention is to reform and deregulate the sector so as to encourage competition and efficiency, to avoid any form of subsidy, to promote private investments, to protect the environment and to ensure public safety etc.

- For the Promotion of RETs
    - Many solar PV systems with an aggregate capacity of over 600 kW have been installed in the rural areas for various applications including 25 health centres, over 100 village water pumps, 70 school lights and power supply, general communication purposes, light houses, powering remote offices, etc.

    - An Energy Research and Training Centre has been established by the Ministry in Asmara with the purpose of undertaking research and development activities on renewable energy resources and technologies (RETs); installations, repair and maintenance of RETs; training of RETs technicians and providing demonstration to the public; improvement of stoves etc;

- Efforts to improve energy supply and services in rural areas

Rural electrification

The mode of electrification in the densely populated Zobas of highland Eritrea is being done through extending the grid. With capital assistance from Sida, the Ministry of Energy and

Mines and EEA have embarked on extending the grid to many of the villages around large cities, major roads, transmission and distribution lines.

With respect to rural electrification the following two tables reflect the recent government excellent commitment.

Table 3-4 Rural electrification completed 1999-2001

Project Area	Number of Villages/towns	Project cost (US$)
Aditekelezan	11 villages + 1 town	297,189
Dibaruwa	10 villages + 1 town	403,131
Elabered	2 villages + 1 town	142,737
Hagaz	1 village + 1 town	193,043
Teseney	3 Villages	413,900
Total	27 Villages +4 towns	1,450,000

Table 3.4 reflects that around 14,100 households have benefited from the recently completed electrification programme. During the coming 3 years (2002-2004) the villages and rural towns programmed to be electrified is shown in Table 3.5. Around 46,200 Households are expected to benefit from the electrification programme of 2002-2004.

Table 3-5 Rural villages and towns planned to be electrified, 2002-2007

Project Area	Number of Villages/towns	Project cost (US$)	Status of implementation
Himbirti	17 Villages	319,029	In progress
Mekerka	12 Villages	484,175	In progress
Mendefera	13 Villages	399,903	In progress
Keren	14 Villages	2,420,437	Expected to start in 2004
Barentu	7 Villages	2,498,559	"
Dekemhare	40 Villages	3,314,014	"
Adikeyieh	26 Villages	1,633,461	"
Nakfa	1 Town	324,660	"
Afabet	1 Town	324,660	"
Omehajer	1 Town	242,718	"
Tsorona	1 Town	242,718	"
Tio	1 Town	324,660	"
Total	129 Villages + 5 towns	11,367,378	"

Source: Ministry of Energy and Mines, Eritrea Electric Authority 2002-2004 Budget (EEA,2001)

- ***Efficiency Improvement of the Traditional Mogogo Stove 'Adhanet'***

The task of developing and designing an improved *mogogo* stove for baking *injera* is one of the top priorities of the Ministry of Energy and Mines of Eritrea. Recent energy use surveys conducted by the Department of Energy (Lahmeyer, 1997 and DoE 1998) show that about 50 % of the energy use by Eritrean households is for baking injera, and more than 80% bake it using wood. The firewood cookers are the least efficient, inconvenient and unhealthy with the following characteristic design problems: -

- The heat from the burning fuel is not enclosed in a firebox, so much heat escapes;

- The mogogo geometry is not optimised to transfer heat well to the baking surface;
- Much smoke is produced leading to health problems for those baking with the stove;
- Due to poor air supply, it is often difficult to get the fire started. Blowing, and kerosene are often used;
- With the exposed flame and floor-level construction, the burning stove is dangerous to children.

Through research and development efforts by the Ministry, the efficiency of the traditional biomass *injera* cooking stove has been more than doubled from below 10% to over 20%. Artisanal women have been engaged in the design, testing and erection of such smokeless improved stoves right from the beginning. A major programme is being undertaken to disseminate such stoves to the rural areas with over 12,000 so far installed. This will be of great benefit to women as they shoulder the responsibility of fuelwood collection and cooking. The Ministry in collaboration with the local administrations has nearly managed to localise the production of key components, the fire grates by artisanal women and the cement block pipes for the chimneys by local manufacturers.

♦ *Summary of Benefits of the Improved Mogogo*:

- Improved stove use will decrease deforestation pressures, as well as reduce the emission of greenhouse gases, which now stands at 0.6 tons of CO_2/household/year;
- The standard of living will increase at the household level;
- Wood or dung collection labour will now be reduced by at least 50%;
- Due to decrease in wood collection duties, students will be able to spend more time studying;
- Cooking time is reduced, and so is cooking labour;
- Household cash expenditures are reduced from reduced wood and kerosene purchases;
- The health of people in the household will improve due to nearly eliminating the inhalation of smoke, respirable particulates, and other toxic emissions during cooking;
- There is also a social benefit, as cooks will no longer have clothes that smell of smoke.

The latest estimate for the external costs for the improved stove is about 10 US $. Eritrea deserves to get a carbon credit for this programme as it has a global benefit in abating greenhouse gas emissions. To this effect, the Ministry of Energy and Mines is dealing with brokers that facilitate sellers and buyers of carbon credit. Future dissemination efforts will include tree-planting component. This improved stove dissemination programme has won the distinguished Ashden Awards for innovations in renewable energies in developing countries in June 2003.

4. DESCRIPTION OF THE PROJECT

4.1 Asmara Power Distribution Rehabilitation and Voltage Conversion

The project intends to implement the Asmara Power Distribution (rehabilitation and voltage conversion) and its immediate surroundings to alleviate the acute shortcomings of the distribution networks and enable the adequate, reliable and sufficient electric power supply to domestic, commercial and industrial consumers from the 4x21 MW Hirgigo Power Plant, which is commissioned and completed by June 2003.

The main outputs of the project will be:

i) *Strengthen and make reliable* the old 50/5.5 kV substations at Asmara center, Gejjeret, Belesa, Denden, Tsada Kristian and Mai Nefhi by extending 12 km of 66 kV transmission and installing 4x12.5 MVA, 66/16 kV transformers and transferring 2x6 MVA, 66/16 kV transformers.

ii) *Convert the existing 5.5/0.23 kV Conductor and transformer systems to 15/0.4 kV system*, which involves voltage conversion by installation of 50 km of underground cable, 75 km of open overhead lines, 30 transformers cabins, 250 transformers on poles, updating the switching and protection system etc.

iii) Upgrade and modernise the existing *low voltage distribution system* which is outdated, very old and undersized to meet the electrical load requirement of Asmara City by installation of 40 km underground cable, 300 km Aerial Bundled Conductor (ABC) and 100 km of open wire overhead system.

The project has four main activities: detailed engineering and preparation of tender documents; procurement of materials and equipment; mechanisation equipment, tools and training; and turn-key erection and construction works. Practical training in erection, construction; installation techniques, in medium and low voltage lines etc. will be undertaken in Eritrea during 1-2 months prior to commencement of works, which will be carried out by expatriate experts in collaboration with EEA.

Background

The project was initiated by EEA in 1994. The Government of Eritrea obtained a grant from the Government of Switzerland to finance the consulting service for the Feasibility study in September 1995. Two consulting firms, IVO of Finland and Electrowatt of Switzerland jointly were selected to carry out the study in December 1996. The Government of Eritrea has, through the Eritrea Electric Authority (EEA) requested the World Bank and other donors to finance the Power Distribution Project (Asmara Voltage Conversion and Rehabilitation). On April 1998, IVO of Finland and Electrowatt of Switzerland submitted a feasibility study, which concluded that there is a definite need for the Power Distribution Project (Asmara Voltage Conversion and Rehabilitation Project). The consultants estimated the total cost of the Project to be about 58 MUSD. Since then, the EEA has constructed several overhead medium voltage lines in the suburbs of Asmara and has also up-graded the voltage to 15 kV

in these areas. This has led to the reduction of cost estimates to about 37 MUSD and updated during February 2003, to about 34.423 MUSD allowing for inflation, as more overhead extensions were realised by EEA. A more refined cost estimate is expected to be presented by the international design consultants in the course of their on-going work.

Thus, the government of Eritrea is now requesting for financing of the "Power Distribution Project (Asmara Voltage Conversion and Rehabilitation Project) having a ceiling budget of 34.423 MUSD to be obtained from the World Bank, the Government of Italy, NORAD, etc.

Project Justification

The existing distribution system in Asmara and surrounding is outdated and old. Because of high demand the network is heavily overloaded resulting in high line losses and bad quality services. The Consultants IVO/Electrowatt submitted the Final Report on the Asmara Voltage Conversion and Rehabilitation project "with the following " Technical Justification": -

- For coping with the growing power demand and the required extensions of the Medium Voltage (MV) mains the present 5.5 kV operation voltage yields very limited possibilities. The maximum allowable current loading of the existing conductors has reached capacity loading or has already exceeded on various sections of the system. The only way how to meet the estimated future load growth of about 250% higher loading of the distribution system (until say 2020) at least requires the doubling of the present MV combined with using of large conductor sizes.

- Apart from the problem to transmit higher loads on the 5.5 kV level the worst technical situation of the system components has to be considered. The existing equipment has been in operation for the last 40-50 years and most of it has passed its life expectancy and the system voltage is obsolete, out of use internationally and materials not available in the market.

- The difficulties with replacements of 5.5 kV apparatus with suitable equivalent new material and the steadily increasing maintenance costs are the other reason for accelerated replacement of the outdated and obsolete 5.5 kV voltage levels with a higher voltage of international standard.

Selection of a suitable Voltage level and equipment

A suitable voltage level for MV distribution systems in size of Asmara area and suitable for peak load figures upto 100 MW lies between 15 and 20 kV. The 15 kV level has been selected for Asmara City (the same for all Eritrea) and is believed that this MV level is sufficient to efficiently distribute electrical energy to the load centres in Asmara.

MV/LV switchgear; Generally the use of circuit breakers for protection of MV/LV feeders are recommended.
15/0.4 kV Transformers; Generally 3-phase MV/LV transformers shall be installed at all locations of Asmara to facilitate adequate and reliable power supply to residential, commercial and industrial areas.

Strengthen and Make Reliable the old Substations

The administration of Maakel Region has initiated urgent "Development Plans" of twenty-one (21) zones in and surrounding Asmara for housing, commercial and industrial centres. The electricity demand of the zones is estimated at about 20 megawatts i.e. about one MW per zone. In order to cope with adequate and reliable supply to the new zones and their surrounding it is necessary to modernize and strengthen the existing substations at Asmara Centre, Gejjeret, Denden, Belesa, Tsada Kristian and Mai- Nefhi. These substations have been upgraded from the old and outdated 50 kV system to 66 kV system and within this Project, EEA is proposing the following: -

a- At Asmara Center Substation to add 1x12.5 MVA, 66/15-5.5 kV transformers with associated switch gear and protection equipment

b- At Gaggeret Substation to add 1x12.5 MVA otherwise same as (a)

c- At Denden Substation to install 1x12.5 MVA otherwise same as (a)

d- At Belesa Substation to install 1x12.5 MVA otherwise same as (a)

e- At Tsada Kristian Substation to add 1x6 MVA, 66/15 kV transformer (to be moved from Belesa) otherwise same as (a)

f- At Mai-Nefhi Substation to add 1x6 MVA (to be moved from Denden)

g- Extend 66 kV underground transmission cable from Asmara East Substation to Asmara Centre that is feeding power from 2x60/40/20 MVA substation directly to the load centre, relieving the heavily loaded 66 kV Asmara East-Belesa transmission line. The proposed transmission line, 66 kV underground cable, is to pass through developed area not suitable for open wire overhead transmission.

h- Extend from Gejjeret substation to Denden substation same as (g)

i- Extend from Asmara East substation to Gejjeret substation same as (g)

Conversion of the Existing 5.5/0.23 kV to 15/0.4 kV System i.e. Voltage Conversion

The centre of Asmara City is currently being supplied from an overloaded and aged 5.5 kV medium voltage system. Apparatus is obsolete and inefficient to operate. The 5.5 kV distribution transformers are loaded near or above rating and at the end of their life; they need to be replaced. These conditions mean that the city distribution losses (according to EEA statistics) are around 16% and voltages are inadequate and no load growth is possible. Some of the feeders are so overloaded that EEA has dropped customers (and load) to avoid multiple cable failures.

To facilitate continued domestic, commercial and small industry growth in the core of Asmara the 5.5 kV system must be replaced with 15 kV system. The multiple open-wire and cable 230/127 V secondary is also operating above capacity and is proposed for replacement

with 400/230 V secondary. Additionally, high voltage transformation and switchgear is also required to replace obsolete 5.5 kV apparatus and to serve the growing load. Most of the 5.5 kV apparatus (switches, transformers, fuse holders, arrestors etc.) are old and antiquated; and thus not reusable. In view of the above the following major up-grades and input works, based on the IVO/Electrowatt Feasibility Study, are to be carried out for the proposed Asmara Voltage Conversion and Rehabilitation Project:

New underground 15 kV cables to replace some old 5.5 kV cables and to pick up inner city loads;

Overhead 15 kV lines to replace some 5.5 kV distribution in the city and to connect city distribution to newly strengthened substations;

Underground cables for 400/230 V secondary distribution to replace the obsolete 230/127 V secondary system;

Aerial bundled Conductors (ABC) 400/230 kV overhead secondary to replace the open wire 230/127 V system. Bundled conductor will make the secondary usually less intrusive and safer for the public;

Install enclosed distribution transformation centres, 15/0.4 kV complete with Switchgear;

Install overhead transformer stations 15/0.4 kV to replace existing 5.5/0.23 kV transformers.

Reasons for Financial Support

Donor assistance is required as it is highly unlikely that the government would be able to fully resource the project without substantial donor funding. The World Bank and other donors (Norway, Italy etc.) have shown interest to finance the "Asmara Voltage Conversion and Rehabilitation Project" which has emanated from the mutual interest to increase the pace of economic and social development thereby improving, upgrading and modernising the Asmara city electricity supply.

Expected End of Project Situation

Upon completion of the "Asmara Power Distribution", the electricity supply system of Asmara and the immediate suburbs will be substantially increased and become more reliable as per the following indicators: -

- Improved service quality through better voltage, higher capacity and fewer outages;
- Reduce system losses; from 16% to 8%;
- Reduce longer term overall power system operating costs, with lower losses, and cost effective operations and design through modern practices training;
- Promote economic growth through better power quality (voltage regulation), accessibility (more capacity) and reliability (fewer outages).

Development Objective

The development objective is, through upgrading and improvement of the capacity and reliability of the Asmara City electricity supply, to contribute to economic growth and job creation by facilitating dependable supply to domestic, commercial, industrial and small agro-industrial consumers in the city and its suburbs.

Immediate Objective

The project objective is to sufficiently increase capacity, reliability and improved voltage levels of the electricity supply to Asmara city and the surrounding areas so as to offer all present and potential consumers a reliable supply at all times, as well as a reduction of the transmission and distribution losses and a great facilitation of future expansion on modern standards of the distribution system (network).

Strategy for Implementation

The implementation method must ensure flexibility and rationality, taking into account EEA's experience and expected availability of EEA's resources as well as any interface problems between project components. The implementation involves a phased voltage conversion and rehabilitation works to be executed as per the proposed reconstruction procedure prepared by IVO/ELECTROWATT. The project components will be implemented in accordance with the following strategic approaches: -

- The preparation of network maps, appointment of a consultant etc, will be carried out by EEA and with the approval of the Bank;

- The materials and equipment necessary for the erection of substations and construction of MV and LV lines will be procured under the World Bank "Standard Bidding Documents for the Supply and Installation of Plant and Equipment";

- The installation, erection and construction of substation equipment, MV and LV distribution network is to be carried out by an expatriate engineering consultant who would be the most favourable responsive bidder;

- Training of the operation and maintenance staff of EEA will be carried out as part of the erection and construction works. Training will have to be based on clearly defined performance objectives.

The elaboration of all preliminary design and tender documents is taking place in Asmara, in close cooperation with EEA's engineering staff in order to achieve a maximum exchange of know-how and professional experience.

Inputs

The inputs needed for project activities are divided into inputs to be provided or financed by EEA and inputs to be financed by the Donors.

Inputs to be provided by EEA are: -

Preparation of Asmara City distribution network maps on a scale 1:4000, to be received and approved by the consultant and implemented by the contractor;

EEA is expected to provide inputs in the from of human resource counterparts for MV and LV distribution construction and engineers for the planning, coordination and follow-up in cooperation with expatriate specialists from material suppliers and appointed project consultants. EEA is expected to provide funds to cover the local costs in relation to the project.

Funds to cover partial local costs such as labour, land acquisition and compensation for line right-of-ways, import duties and taxes inside Eritrea etc.

Inputs to be financed by the Donors are:

Funds for covering all foreign exchange costs related to the supply of materials and equipment;
Funds for procurement of vehicles, construction equipment, working tools etc.;
Funds for consultant, vendor experts, training of EEA staff, and to update and /or add computer hard and software.

Activities

The project consists of the following main components: -

Preparation of terms of reference (TOR), tendering and appointment of consultant (TOR already prepared in cooperation with World Bank mission).

Mapping, planning, design, preparation of tender documents, tendering, placing order with manufacturers and suppliers.

Manufacturing, shipping of materials and equipment and erection of substations, construction of 66 kV and MV & LV lines and training of operation and maintenance (O & M) EEA staff.

Putting into operation the newly installed up-graded systems and remove obsolete and outdated materials and equipment.

Results

The project shall result in the following: -
Extension of 66 kV underground cables from Asmara East to the existing 66/15 kV substation of Asmara Centre and Gejjeret; from Gejjeret to 66/15 kV substation of Denden.

Increase capacity at Asmara Centre, Gejjeret, Denden, Belesa, Tsada Kristian and Mai Nefhi 66/15 kV substation by installation of 4x12.5 MVA and 2x6 MVA transformers.

Construct MV and LV underground cables, overhead lines, and transformation stations

Remove old replaced lines and store useful material and equipment and scrap obsolete and old materials and equipment.

Assumptions

The assumptions at each project level are the following:

Activity level (to achieve the result)

Legal permissions for land access obtained and, if applicable, appropriation of land for right-of-way carried out;

Funds for covering local costs such as land compensations; and import duties and taxes (within Eritrea) made available from EEA;

EEA staff available for project preparation as well as implementation which are the role as the Employer and supervision of works;

Unhindered import of all equipment and materials needed for project implementation;

Result level (to achieve the project objectives)

New 4x21 MW generation, 132 and 66 kV substations and transmission lines are operational;

Reliable electricity supply of adequate capacity throughout the lifetime of the distribution network;

Funds and staff for operation and maintenance made available by EEA;

Project Objective level (to achieve the development objective)

Continuation of the relative peace and finalisation of the demarcation process with Ethiopia are key inputs for social and economic development;

Development of increased basic infrastructure in Asmara City and surroundings, such as roads, telecommunications and water supply with a view to developing domestic, commercial, industrial potential as well as tourism;

The domestic, commercial and industrial consumers can afford to connect to electricity and equipment and installation material;

Electrical equipment and installation materials are available on the market for potential consumers.

Risks

Risks which may delay the achievement of the project result are the following: -

- Funds and staff not timely available
- Hindrance and / or delays in imports of equipment and materials

Risks which may delay or prevent the achievement of the project objective are the following:

- The lack of a reliable supply of power of adequate capacity from the EEA grid system
- Funds and staff for operation and maintenance not available
- Delays in special design or implementation measures to be taken into account, unforeseen changes in the city plan etc.

Organization and Administration

EEA, in consultation with the World Bank, will be the official employer of engineering contractors to conduct the construction work on turnkey basis. EEA can assist the contractor in the recruitment of local employees and or subcontractors. The project will thus be organised and implemented in cooperation with EEA.

It is anticipated that direct coordination of activities between EEA and the donors is made with occasional meetings between officials of EEA and the donors in Asmara. Representatives from the project-engineering consultants may be asked to participate in these meetings, if needed. Tendering and contracting agreements for project implementation for the donor-funded components will follow World Bank procedures.

Indicators and Means of Verification

Indicators for *the development objective* are: -

- An increased GDP growth
- Amount of new investments
- Number of new businesses and commercial entities

Means of verification of this indicator are the national statistics

Indicators for the *project objective* are: -

- Energy sales (kWh) and maximum demand (MW);
- The improvement of overall system losses in Asmara Area from 16% to 8%;
- Decreasing number of power supply interruptions (i.e. planned and forced);
- EEA financial results.

Means of verification of these indicators are EEA statistics and EEA financial statements.

Indicators for the *results* are: -

- Approved contracts for consultancy;
- Approved contracts for supply including training
- The final milestones of the project implementation, i.e. erection / construction, testing, commissioning and handing over of the project components.

Means of verification are the consultant's reports, the project completion report, the taking over certificate and the defects liability certificates.

4.2 Rural Electrification Component

Project Title: Rural Electrification of the villages/towns around Keren, Barentu, Dekemhare and Adi Keih urban areas

Implementing Agency: Eritrea Electric Authority (EEA)

Duration: 4 years

Starting Date: July 2004

Eritrean Contribution: Nakfa 29.145 million

Donor Contribution: USD 9.25 million

Brief Project Description:

The project intends the implementation of rural electrification to villages and small towns in the suburbs of four urban areas in Eritrea. This will allow electricity access to approximately 28,000 residential and over 1,300 small industrial and commercial consumers with the national grid system.

The main outputs of the project will be:

i) Installation of 858 km 15 kV lines;
ii) Installation of 264.6 km of low voltage lines; and
iii) Installation of 328 distribution transformers.

The project has three main components: procurement of distribution materials, mechanisation equipment, tools, practical training and installation of equipment. EEA will be the contractual partner for all major contracts in the project. Practical training in installation techniques will be undertaken in Eritrea during 4-5 weeks prior to the installation work, which will be carried out by expatriate experts in collaboration with EEA.

Background and rationale for the project

One of the major concerns of the people and Government of Eritrea is the environmental degradation - manifested by loss of eco-system, poor quality soil and exposure to erosion, aridity, etc., which has made Eritrea even more vulnerable to climate change and its effects, loss of bio-diversity and desertification. One of the major causes for these effects is the continued reliance on biomass energy in a form that is unsustainable.
Improvement of the living conditions of the people can not be realised without adequate and affordable supply of modern energy. Rural electrification will boost productivity and increase economic opportunities. It will thus make rural communities more attractive to live in and hence alter the tendency for young people to migrate into larger towns and cities in search of work and better life.

Many factors have constrained access to modern energy services in rural Eritrea. Poverty is perhaps the single most important of these, as people normally move up the energy ladder when their income increases, with people shifting from locally available traditional fuels to modern commercial energy carriers as well as to convenient and energy-efficient conversion devises. Lack of pro-rural energy policies and appropriate institutional frameworks is another important factor that has made rural energy programmes not to get the necessary momentum and vigour in the implementation process. The poor linkages and co-ordination between the various stakeholders involved in rural development with the necessary modern energy services is also responsible for the poor performances observed in many developing countries.

Conflict is another factor that limited investment in the development of indigenous energy resources and rural electrification. In Eritrea, the thirty-year war of liberation and the 1998-2000 conflict with Ethiopia has seriously hindered expansion of the energy infrastructure, particularly to rural areas. Internal mechanisms for generating local financial and technical resources are also far from developed in the country.

As EEA has to attain financial self-sufficiency according to the prevailing policy, it focuses on cost-effective expansion of electricity infrastructure. The EEA considers inter-city extension of electricity from the central grid system to be economically feasible only if the combined load of customers in a town or a city to be interconnected exceeds 2 MW. Rural villages are thus regarded as unattractive for electrification from EEA's resources, eventhough, villagised rural settlements particularly in highland Eritrea, is conducive to grid extension. Moreover, the low level of living standard of the rural communities does not allow covering the full connection costs of T&D lines to their specific villages. Thus, since subsidies are not supported by the policy, rural electrification cannot be conducted using EEA resources alone. Thus, from the total number of over 2600 villages in Eritrea only about 40 villages in the vicinity of urban centres have so far managed to mobilise enough own resources to get access to electricity; at present below 3% of the rural population has access to electricity. These conditions has induced the Government to come up with a policy initiatives to make a one-time capital investment in rural electrification programmes together with its development partners, as a major component of its socio-economic policy.

The Government of Eritrea has always given high priority and support to the power sector since independence as manifested by the huge capital investment channelled to it. In the last five years, the Government has secured a soft loan amounting to US $ 200 million from its development partners. With this money, an 84 MW thermal generation plant and associated 80 kms of 132 kV transmission lines has been erected connecting Massawa, the site of the plant, with the major market centre of Asmara and 160 kms of 66 kV from Asmara to the other market centres of Keren, Dekemhare and Mendefera. Many of the satellite towns near these major towns have already been integrated electrically from EEA's own sources.

Despite such support to the power sector, grid extension to the rural areas is a recent initiative. Government efforts to improve rural energy supply are just beginning. The emerging initiatives involve four mechanisms, namely,

- rural electrification through grid extension,
- improvement of biomass sources through various afforestation/reforestation programmes,
- dissemination of improved stoves, and
- assessment of potential in conventional and renewable energy resources for eventual development.

As part of the rural electrification program, the Government of Eritrea has, through the Eritrea Electric Authority (EEA) requested the World Bank and other donors to finance the Rural Electrification Project, which is comprised of the following.

Expanding electricity service to areas near the towns of Keren, Barentu, Dekemhare and Adi Keih using new Rural Electrification practices.

Dekemhare and keren are already connected with the national grid. Adi Keih and Barentu have a local grid but EEA is planning to interconnect them with the national grid from its own resources.

The Government's long term policy is to electrify all rural areas gradually. EEA is committed to provide its own inputs and support necessary for the project's successful completion and operation, thus increasing the pace of development of electricity in rural areas, and to decrease the dependency on kerosene for lighting and the dwindling biomass energy resources for cooking and heating.

Special Considerations

Rural electrification will energise the government's poverty reduction measures and help ease some of the heavy workload on women and children for agricultural and household tasks. Health services in rural areas, school performances and clean water supply will be improved by the availability of electricity.

The current unsustainable use of biomass fuels damages the environment. The search for fuelwood often involves chopping down local trees. As trees disappear, fuelwood has to be sought further and further away. Using dung and crop residues as fuel reduces the amount available for use as a fertiliser for growing crops. So, the introduction of electricity in rural areas will decrease deforestation or desertification pressures and will help in increasing the fertility of the soil.

Project Immediate Objective

The immediate objective of the project is the implementation of rural electrification by extending the local electricity grid to hitherto unelectrified small towns and villages close enough to the four urban centres of Dekemhare, Adi Keih, Keren and Barentu.

Inputs

Inputs include local staff, infrastructure, equipment, operations costs, technical assistance for training and other inputs. A breakdown of these inputs is given in Table 2.

Table 4-1 Summary of Inputs

Provided by EEA	Provided by MoEM	Provided by Donors
15 kV Distribution Line, Distribution Transformers and LV Distribution Lines 1. Labour (1 Foreman, 3 Linesmen, 20 Labourers) 2. Transport of equipment from Massawa Existing facilities required for the works: Offices/Furniture Stores/Workshop and equipment Generators Existing transport facilities for the works: Pick-ups Truck As required: Hand tools Fuel Spare parts, consumables As required for EEA Supervision Engineer Supervisor Clerk/Typist Driver	For the Practical Training Use of Energy Training and Research Centre	15 kV distribution line 3. Common material 4. Conductors Distribution Transformers 3. Common materials 4. Transformers & LV cables LV Distribution Lines 3. Common materials 4. Conductors Transport facilities: Truck with power auger; Truck with crane, various tools. Technical assistance for training

Activities

- Procurement of Equipment/Services and Practical Training
- Procurement of equipment (tender document, tendering, contract awarding)
- Port clearance and inland transport of equipment
- Appointing an external consultant to design, plan innovative rural electrification options and supervise and document the entire work
- Practical training in Eritrea

Electrification of Keren Area (see also map at the end)

Construction of Medium Voltage Distribution Lines:
218 km of 15 kV distribution lines with 35 and 50 mm^2 copper equivalent AAC conductors on wooden poles from Keren Substation up to Melebso to the north, Afabet to the East and Mensura to the south east. All the towns and villages of Keren Area will be connected by either taping or extending from the existing 15 kV Keren – Elabere'd, Keren – Hagaz and Keren Hamelmalo lines.

Construction of three phase Low voltage Distribution lines:
Six small towns and the ten villages of the Keren Area: 60 km line with 25, 35 and 50 mm^2 copper equivalent AAC conductors on wooden poles.

Installation of Distribution Transformers:
Six small towns and the ten villages in the Keren area - Gush, Haddish Adi, Terenque, Shieb, Debresina, Libana, Halhal, Mai Awalid, Melebso, Mensura, Shaftaque, Karotnejar, Hirkok and Aderde - 13X100 kVA + 15X50 kVA + 50X25 kVA two pole mounted transformers.

Electrification of Barentu Area

Construction of Medium Voltage Distribution Lines:
All towns and small villages in the Barentu Area will be supplied by extending and taping 295 km 15 kV distribution line with 35 and 50 mm^2 copper equivalent AAC conductors on wooden poles.

Construction of three phase Low voltage Distribution lines:
Six small towns (Gogne, Tokombia, Binbina, Shambuko, Areda, Mogolo) and villages in between these towns in the Barentu area: 30 km line with 25, 35 and 50 mm^2 copper equivalent AAC conductors on wooden poles.

Installation of Distribution Transformers:
Barentu area small towns and villages will have 10X100 kVA + 10X50 kVA + 20X25 kVA two pole mounted transformers.

Electrification of Dekemhare Area

Construction of Medium Voltage Distribution Lines:
205.2 km of 15 kV distribution lines with 35 and 50 mm2 copper equivalent AAC conductors on wooden poles from Dekemhare Substation up to Tsorona to the south, Kurbaria/Adi Rassi to the west, Gaden and Aderada to the north and Adi Quita to the east. All the towns and villages of Dekemhare area will be connected by extending from the existing 66/15 kV substation in Dekemhare.

Construction of three phase Low voltage Distribution lines:
All small towns and villages of the Dekemhare Area: 116.7 km line with 25, 35 and 50 mm^2 copper equivalent AAC conductors on wooden poles.

Installation of Distribution Transformers:
All small towns and villages in the Dekemhare area: 108x25 kVA + 30x50 kVA + 16x100 kVA two pole mounted transformers.

The electrification of the Dekemhare area includes the villages of Keih-Quor, Sesah, Military Camp, Hospital, Alla, Gaden, Deki Nazo, Awli Tsoru, Azamir, Zeban Angeb, Damba, Wekerti, Adi Araada, Amhur, Arato, Korbaria, Haren, Adi Nefas, Adi Rassi, and the Villages of Tukul, Gura, Enda Deko, Ziban Seraw, Adi Nefas, Mai Edaga, Godeyti, Halibo, Mai Yaha, Kertse Kemte, Kinafna, Mai Aini, Tsorona, & extension of 15 kV line from Segeneyti to the villages Akrur, Hebo, Adi Angefom, Degra, Ewanet, Digsa, Adi Hadid, Berakit, Birkito, and Adi Quita.

Electrification of Adi-Keih Area

Construction of Medium Voltage Distribution Lines:
All towns and small villages in the Adi-Keih Area will be supplied by extending and taping

133.8 km 15 kV distribution lines with 35 and 50 mm^2 copper equivalent AAC conductors on wooden poles.

Construction of three phase Low voltage Distribution lines:
All small towns and All villages of the Adi-Keih area: 57.9 km lines with 25, 35 and 50 mm^2 copper equivalent AAC conductors on wooden poles.

Installation of Distribution Transformers:
Adi-Keih Area small towns and villages will have 29x25 kVA + 21x50 kVA + 6x100 kVA two pole mounted transformers.

The electrification of the Adi-Keih area includes villages of Emba Chilai, Tegeren, Ento, Adi Lejji, Quatit, Mirgatse, Emba Quaquat, Embeito, Ziban Zigib, Adi Wegera, Hawatsu, Mendefera, Adi Kanta, Awhine, Berhenet, Halai, Haddish Adi, & extension of 15 kV Taping Adi-Keih - Senafe to the following villages; Quahaito, Egla, Embalaka, Mekayih, Mai Sagla, Serha, Ambeset Geleba, Meneksoyto.

Results

The main indicators for achievement of outputs will be:
- Km of installed medium voltage line
- Km of installed low voltage line
- Number of installed distribution transformers
- Number of connected households and enterprises

These indicators should be verified through Project Progress Reports.

Assumptions

The key assumptions underlying the project are that:

- New 66 kV lines are installed between Keren- Barentu and Dekemhare Adi Keih
- Consumers can afford the cost for final connection

In order to achieve the results it is assumed that:

- Necessary capital goods, materials and personnel are available;
- Access to farm land is available;
- EEA fulfils its obligations.

Risks

Based on the experiences gained from the implementation of previous rural electrification projects, there are some activities that could lead to either project delays or increased expenses:

- Lack of proper co-operation from key stakeholders involved in project implementation
- Crude initial estimation of materials required and changes in town/village growth plans
- Logistical delays

Strategy for Implementation

The strategy for the rural electrification is based on EEA undertaking the works, with some training of EEA technicians in the practical installation work and safety aspects. A consultant shall be engaged to study the feasibility of single-wire-earth-return systems in Eritrea and other innovative approaches to rural electrification

The project involves a phased implementation of the rural electrification. This is based on an assessment of the current conditions, availability of labour and current workloads for installation and maintenance.

Organization and Administration

EEA will devote sufficient staff and competence and bear the overall responsibility for the implementation and shall be the contractual partner for all works in the project. During the project implementation, EEA will be committed to fulfil efficiently all the activities and procedures of work.

The practical training to be carried out at Energy Research and Training Centre and in the field must be tailored to the educational level of the staff involved. EEA will undertake careful planning to ensure that the project is adequately staffed and co-ordinated within EEA.

The technical aspects of the project will be planned, co-ordinated and implemented by the Project Office to be established within EEA's Distribution Division. This Office will be fully responsible for all operational issues, although some practical training will be held at the Ministry's Research and Training Centre. EEA will be responsible for sustaining the outputs and project objectives on completion of the project. During the construction phase, the Ministry of Energy and Mines had agreed with the World Bank experts to establish a Project Management Unit within the Department of Energy whose duties and responsibilities will be presented in Chapter 8.

Indicators and Means of Verification

The project's contribution towards the development objective will be indicated by the following developmental achievements relative to equivalent areas without rural electrification implemented:

- Increased number of new income generating activities and social amenities such as: cold stores, mills, restaurants, bars, cottage industries, hotels, sawmills, hair dressing saloons, small factories.
- Increased agricultural production, storage, processing and marketing facilities
- Increased residential customers
- Improved health services
- Extended time available for work, teaching and adult education
- Improved water supply for irrigation, human and livestock consumption
- Increased communications and transport facilities.

5. DESCRIPTION OF THE BASELINE ENVIRONMENT

5.1 The Physical Environment

Location

Eritrea extends from 18°02'N to 12° 22'N in a north-south direction, and 36°26'21''E to 43 ° 13' E in an east-west direction. With an area of about 125,750 sq. km., it is the 38th largest country in Africa, larger than many European countries like Austria, Belgium, Switzerland, Luxembourg, etc. The country shares its longest boundary line with Ethiopia, 865 km, in the east and south, followed by Sudan, 600 km, in the west and northwest, Djibouti, 75 km, in the southeast, and the Red Sea.

With a coastline of over 1200 km along the Red Sea extending close to the Bab El Mandeb, the southern outlet of the Red Sea, Eritrea occupies a strategic position in Northeast Africa. Eritrea possesses over 350 large, medium and small islands and islets. The biggest island, Dahlak Kebir, has an area of 643 sq. km, and it is larger than some countries. Massawa and Assab are the two major ports, but there are many small landing spots along the coast. The Eritrean coastline is relatively a smooth one; there are few indentations such as the bays of Hirgigo, Hawakil, Anfil, Edd, Bahir Asoli, Beilul and Assab. Eritrea enjoys a continental shelf of about 56,000 sq. km. Eritrea can harvest a sustainable yield of 70,000 tons of fish every year, but current harvests do not exceed 10,000 tons. Ornamental and coral fishing are other potential resources of the marine and coastal waters of Eritrea.

Geology

Eritrea has varied geology, although it is dominated by Precambrian rocks. The Precambrian rocks, which are older than 600 million years, are the oldest rocks in Eritrea, and all other rocks were deposited on top of them. In the greater parts of Eritrea, the younger rocks have been eroded, and the Precambrian rocks, also known as crystalline or Basement Complex are exposed. These rocks contain a variety of sedimentary, volcanic and intrusive rocks, the dominant ones being granite, schist and gneiss. The Precambrian rocks cover the Escarpment, the Northern, Anseba and Central Highlands, as well as parts of the Western Lowlands. Most of the metallic deposits like gold, copper, zinc and lead sulphides are associated with these rock formations. At the end of the Precambrian Era (570 million years B.P), uplifting took place, which was followed by a period of erosion. The Palaeozoic Era (570-225 million years B.P) was essentially a period of peneplanation. Excepting the pockets of reddish or lateritic rocks seen in the Central Plateau where Asmara, the capital, is located, and or Southern Plateau (Seraye), there are no rocks belonging to this Era.

During the Mesozoic Era (225-70 million years B.P), subsidence occurred, and a shallow sea started to spread first over present day Somalia and Ethiopia and then moved further west and northwest, until it covered the southern parts of Eritrea. This process resulted in the deposition of a number of sedimentary rocks. Adi Grat Sandstome was deposited in the Eastern (Akeleguzay) Highlands and the southern parts of the Southern (Seraye) Plateau, while Antallo Limestone was deposited in the Danakil Plains. The Mesozoic sediments are not found north of the Halai-Digsa-Adi Qualla line. This may mean that either the sea did not cover the areas north of this line, or the deposits were shallow and removed by subsequent erosion.

During early Cainozoic Era (70 million years B.P to present), i.e. Tertiary Period, uplifting and fracturing occurred. This was accompanied by widespread volcanic activity, which led to the flow of huge quantities of basaltic lava, known as Trapp Series. The Trapp Series are found in a narrow belt in a north-south trend, extending from the southern tip of Asmara through the towns of Dibariwa, Mendefera and Adi Qualla to the border. Pockets of trachytes belonging to this Period are also found in Southern Plateau and Eastern Highlands. More recent volcanic activities known as Aden Series or Quaternary Volcanics occurred in the Danakil area. These were associated with the formation of the Great East African Rift Valley, and created basaltic lava and spatter cones. Lastly, the Quaternary sediments that include conglomerates, sand, clay, and reef accumulation limestone in the coastal areas, cover the Eastern Plains and the Western Lowlands.

Physiography

Topographically, Eritrea is a land of great contrasts, with altitudes ranging from about 30 meters below sea level in the Danakil Depression to 3018 meters above sea level on the summit of Emba Soirra. With rugged mountains, escarpments, rolling plains, lowlands dotted with inselberg-like hills, and dissected edges of plateaux, the topographic diversity of Eritrea is quite striking. The country can be broadly divided into four major physiographic regions: The Coastal Plains; The Highlands; The expansive Western Lowlands, and The Escarpment. Each of these major physiographic regions can further be divided into smaller units.

The Coastal Plains are a narrow strip of about 50 km width running parallel to the coast. Stretching from Ras Kasar in the north to Dar Elwa in the south, they extend for more than 1200 km. Their average elevation is less than 500 meters above sea level. The Coastal Plains, along with the Red Sea, occupy the floor of the Rift Valley. The northern half of the Coastal Plains, i.e. from Ras Kasar to the Gulf of Zula, is a low and flat sandy area, which is at places interrupted by east-west running dry river beds and isolated hills like Ghedem. South of the Gulf of Zula, the Coastal Plains are characterised by depressions, volcanic hills of the Quaternary Period, and even block mountains like the Omartu Mountains, which are often considered detached fragments of the central highlands. The summit of some of these mountains reaches close to 2000 meters above seal level. This part of Eritrea is geologically unstable as indicated by hot springs, fumaroles, and earthquakes.

The Escarpment, which is the most wild and picturesque landscape in Eritrea, separates the Highlands from the Coastal Plains. It is a steep area that starts from the edge of the plateau and highlands and ends where the foot slopes give way to the Coastal Plains. The Escarpment is characterise by very deep valleys aligned with north-south trending faults, steep, massif-like hills (Bizen, Lessa, etc.), scarps and precipitous slopes, and intermontane tectonic depressions like Ala, Seled, Damas, Sebarguma, and Ailet .

The Highlands, which are dominantly uplifted Precambrian crystalline surface, occupy the central parts of the country in a north-south orientation, extending from Zoba Debub to the border with Sudan in the north. Excepting the Central Plateau, the Southern (Seraye) Plateau and the Mereb Trough, the surface of the Highlands is rough often made up of small, detached plateaux. Although elevations may reach over 3000, the average elevation of the highlands is 2000 - 2500 meters, but the Mereb Trough, a tectonic depression which separates the Southern (Seraye) Plateau from the Eastern (Akeleguzay) Highlands, has less than 2000 meters. The Highlands have been highly dissected by the numerous rivers that originate from them. The Highlands physiographic region is the most densely populated area in Eritrea.

Most of the major towns and villages are located here, and it forms the economic and political heart of the country.

The Western Lowlands are expansive lowlands, largely covered with Quaternary sediments but crystalline rocks are also found here. These lowlands have an average elevation of 500-1000 meters, but isolated hills towering to over 1800 meters are scattered over the plains. These Lowlands are also dotted with inselberg-like features.

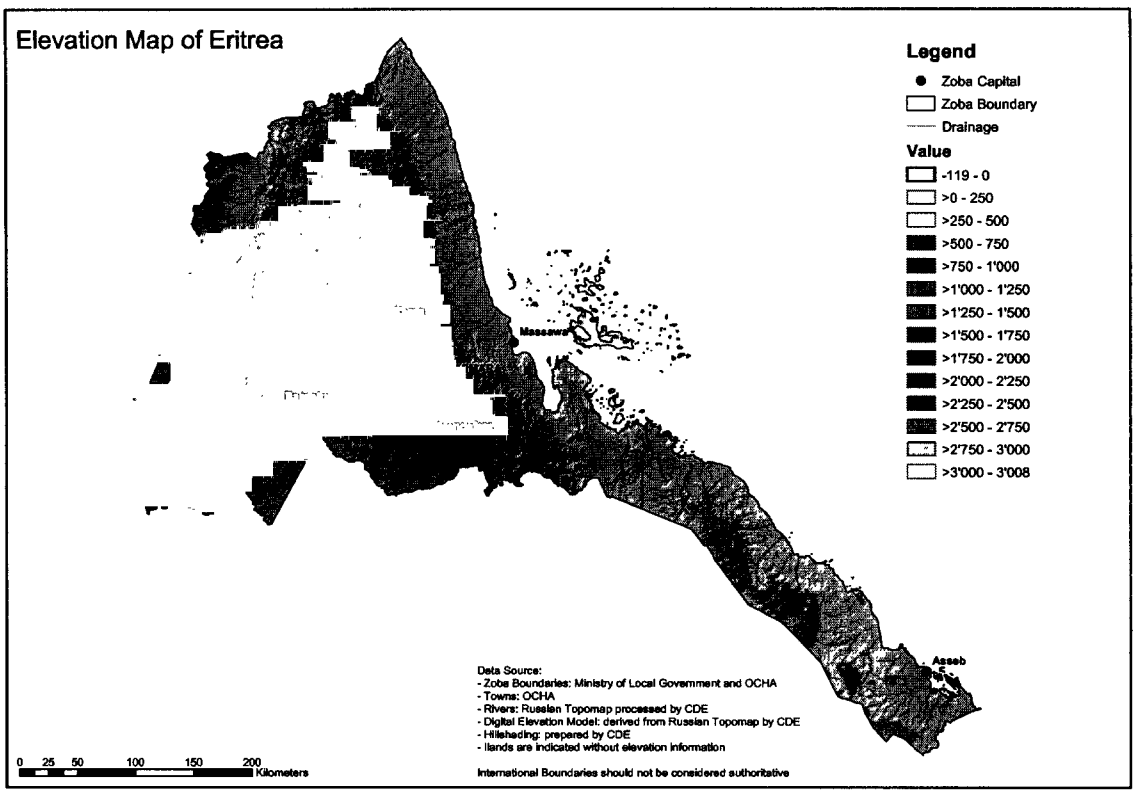


Figure 3 Elevation Map of Eritrea

Rainfall, Temperature and Hydrology

Occupying the eastern part of the Sahel region, Eritrea has an arid to semi-arid climate. The average rainfall in the highlands is 450-600 mm, but small parts of the Western Lowlands and the Escarpment get greater rainfall. The Coastal Plains have drier conditions where rainfall is less than 200 mm. For instance, rainfall in Tekombia is about 900 mm, but falls to 519 in Barentu, 570 in Mendefera, 550 in Asmara, 480 in Adi Keih, 308 in Agordat, 191 in Massawa and 45 in Assab. The Coastal Plains and parts of the Escarpment get their rainfall in Winter, while the rest of the country gets its rainfall in summer. A small part of the Escarpment, commonly referred to as the Green Belt, benefits from both seasons and records the highest rainfall (more than 900 mm). On the other hand, potential evapotranspiration (PET) is very high in Eritrea. It is more than 1600 mm a year in the highlands, and more than 2200 in the lowlands (2201 in Barentu and 2578 in Massawa). The coastal plains are water deficit throughout the year, while the central highlands and southern parts of the western lowlands have water surplus only in July and August.

As the country lies in the semi-arid zone of the Sahel, rainfall is not only seasonal but also poor, unreliable and unpredictable, and it lasts for 2-3 months only. Thus the growing season is short, being 90-120 days in the southern parts of the Highlands where rainfall is 450-700 mm, but falls to less than 45 days in the Coastal Plains, parts of the Western Lowlands, and the northern parts of the Highlands. Eritrea as a whole is a drought prone country.

Temperatures are moderate in the Highlands (18-22°C), but high in the Western Lowlands and Coastal Plains (30°C), but maximum temperatures could go over 40°C in the Coastal Plains and over 35°C in the Western Lowlands. The distribution of temperature in Eritrea is controlled by altitude. Thus isotherms form semi-concentric circles around the highest point in the country. For instance, the mean annual temperature of Asmara (2340 meters) is 16.1 °C, but increases to 24.5 °C in Ghindae (962 meters) and 28.5 °C in Massawa (8 meters). In the Danakil Depression, temperatures may reach 50 °C at times. Temperatures are low during December and January, when lowest minimum temperatures are recorded, but start to increase rapidly in March and April reaching highest in May. Like all tropical climates, daily ranges of temperatures are high (as high as 25-30 °C for some places), but annual ranges are low (less than 10 °C).

Water is a scarce resource in Eritrea. Due to the seasonal nature of rainfall, the country has no perennial fresh water sources such as rivers or lakes. Attempts are being made to supply fresh water from underground sources or harvest rainwater using dams, ponds, infiltration galleries, etc.

According to the Water Resource Department, (WRD) the surface water of the country can be broadly divided into 5 major basins. These are the Setit (7,300 sq. km), Gash Mereb (17,400 sq.km inside Eritrea), Barka-Anseba (41,000 sq.km), Red Sea (44,000 sq.km), and the Danakil (10,400 sq.km). Setit, which has its origins in Ethiopia is the only perennial river. The WRD gauges show that annual flow of Setit at Omhager is 6,280 million M^3, or 199 M^3 per second. Flow rates, however, are very variable, ranging from 13 million M^3 in February to 3340 million M^3 in August. Other estimates put the annual flow of Setit between 5800 and 8000 million M^3 of water a year (180-250 M^3 per second). The Gash-Mereb, which carries 532 mill M^3 a year at Tessenei forms an inland delta in Kassala, Sudan. This river is dry in eight months (November to June), but carries up to 267 million M^3 in August. The Barka-Anseba loses its water in the sandy deserts of the Sudan, but can reach the Red Sea in exceptionally heavy rainfall years. Gauging stations in various sub basins indicate annual flows of 25-50 million M^3 for Anseba and 15-85 million M^3 for Barka. The annual flow to the Red Sea basin is 444.9 million M^3 while the flow to the Danakil basin is 135.9 million M^3.

The underground water resource of the country is even little known. Converging tectonic structures, extensive fault system, alluvial plains, etc provide ideal conditions for groundwater potential. The main aquifers are believed to be associated with limestone, alluvium, fractured basalts, alluvial deposits, and fractured Precambrian rocks. The Precambrian rocks, although impermeable, have been subjected to several orogenic (uplifting) episodes, and in conjunction with the rifting, have resulted in considerable fracturing and shattering, producing ideal conditions for acquifers. According to the study made by WRD, many of the aquifers have relatively higher direct recharge rates of 6.5 to 17.5 mm a year. Boreholes drilled in various parts of the country by the WRD, however, show that yields are less than 5 litres per second in most cases; yields of more that 10 litres per second are extremely rare.

Soils

The soils of Eritrea are mainly derived from crystalline rocks, volcanic rocks and Mesozoic sedimentary rocks. The major soils of the country are Cambisols (21%), Regosols (16.8%), Lithosols (16.4%), Xerosols (12.2%), Fluvisols (11.7%) and Solanchaks (11.3%), Luvisols (5.1%), and Vertisols (4.7%). The remaining 8% is covered by other soil types like Nitosols, Andosols, Rendizinas, Phaeozems, etc..

The Cambisols, which are found in the southern and south-western parts of the country are either Eutric, Chromic, or Calcic. Calcic Cambisols are often found in the western lowlands with little rainfall. Most of the Cambisols are found in slopes, and they are shallow and in lithic phase, and hence of little agricultural value. If they are deep and without stones, however, they are good for agriculture. The Lithosols and Regosols develop in rugged terrain, are shallow and without profile development, and hence, have no agricultural value.

Xerosols are soils of arid and semi-arid areas with weakly developed A horizon. Those with argillic B horizon are luvic Xerosols while those with calcic horizon are calcic Xerosols, while those without calcic horizon are haptic Xerosols. Most of the Xerosols are in lithic phase. They are found in the north-western parts of the country. These soils have little agricultural value except when they can be irrigated.

Fluvisols are young soils that develop in recent alluvial deposits of river plains, former lakes, depressions, and coastal areas. They are found in the Western Lowlands, Coastal Plains and along rivers courses and fluvial plains. They have good agricultural value except where they are in saline phase as in some parts of the Coastal plains and the Danakil Depression.

Solanchaks are poor, saline soils containing soluble salts that are harmful to plant growth. Most Solanchaks in Eritrea are orthic, although gleyic Solanchaks could be found in pockets. They are found along the Coastal Plains. They can be used for agriculture if the salt can be washed away.

Luvisols are soils with argillic B horizon. These soils have high base saturation and weatherable minerals. They are found scattered in the Highlands and western Lowlands.

Vertisols are heavy clay soils that develop in flat areas. These soils shrink and crack during the dry season, and swell in the wet season. Pellic Vertisols are dark and usually occupy areas that are waterlogged during the rainy season, while chromic Vertisols are brownish in colour and better drained. Although chemically good soils, they are difficult to work as dry soils are hard and wet soils are sticky. Moreover, the sub-soil has poor permeability while water logging restricts plant root growth. They are found in the south- western parts where Setit and Gash cross the border to the Sudan, but pockets are also found in the Highlands. They are highly prized by Eritrean farmers in the highlands due to their ability to retain moisture to be used by crops after the rains have stopped.

5.2 The Biological Environment:

Natural Vegetation

The climax vegetation, i.e., the vegetation that would develop in the absence of human influence, is totally absent in Eritrea. Indeed years of clearance for agriculture and other uses have rendered many parts of the country treeless. Thus, the greater part of the country's vegetation is made up of shrub and grass vegetation. Vegetation distribution shows close association with altitude in the country.

No complete inventory of the plant and animal species has ever been done in Eritrea, although the Department of Environment has recently taken the initiative to record and document the biodiversity resource of the country. Studies done so far have identified 24 vegetation types, each of which is composed of different types of plant species. The list is expected to rise, as the studies becomes more comprehensive.

The most densely forested area in Eritrea, commonly referred to as the green belt, is found between Asmara and Ghindae and extends to the north up to Filfil and Merara. It forms disturbed high forest vegetation. Depending on the altitude, this forest is composed of variety of trees. At the lower altitudes, *acacia tortilis, acacia mellifera, delonix elata, acacia assak, dobera globera, terminalia brownii, bosscia angustifolia,* etc are found. as altitude increases, *olea africana, juniperus procera, anogeissus leicarpus, terminalia brownii, vangueria madadascariensis*, etc. are found.

In areas of long settlement either plantation forests or shrubs are found. The shrubs are composed of either evergreen trees like *euclea shimperi, dodonea angustifolia, rhus natalensis*, or small-leaved deciduous ones like *acacia etbaica, acacia nilotica* and scattered trees like *acacia albida*. Various grasses are also common in the settled highlands like *gluera panicum, pennisetum spp., andropegan spp.* etc. pockets of eucalyptus plantations are also found in the highlands.

In the western slopes, broad-leafed deciduous trees dominate. Dominant tree species include *terminalia brownii, euphorbia abyssinica, boswelia papyrifera, adansonia digitata, albizia amara, ficus vasta, ficus sycomoros, balanites aegptiaca*, etc.

As one moves further to the Western Lowlands, woodland and savannah type of vegetation is found. There are varieties of tree species here. In addition to various species of Acacia (*Acacia mellifera, A. tortilis, A. asak, A. Senegal, A. seyal, A. oerfota, A. nilotica*), *Boscis senegalensis, Cadaba rotundifolia, Zizyphus spina-christi, Boswelia papyrifera, Tamarix aphylla, Combretum fragrans, Albizia amara, Hyphaene thebaica*, etc. are found. In the western and southwestern parts of the Western Lowlands, dominant vegetation is various species of grass, which may grow to a height of 2-3 meters under favourable conditions. Two dominant grass species are Aristide and *Soprghum purpereo-cerileum.*

In the lower Danakil and Red Sea coastal areas around the Gulf of Zula, and south of Beilul, semi-desert vegetation is found. This consists of sporadic, xeromorphic thorny species of shrubs of acacia, which have developed dwarf forms. These shrubs are found in patches; between patches are found small tufts of hardy grass. Halophytic, i.e. salt tolerant, vegetation types, including patches of mangrove forests, are also found along the coast, especially north of Massawa.

Riverine forest is found along major rivers and streams. The composition and size of this vegetation varies from place to place due to rainfall and altitude. In the lower courses of the major Eritrean rivers, the tree species commonly found are *Hyphaene thebaica, Zizyphus spina-christi, Ficus vasta, Ficus sycomoros, Tamarindus indica,* and various species of acacia.

The cutting of tress for fire, construction of houses, and clearance for agriculture has been the major forces of deforestation in Eritrea. According to the Department of Environment, 34 tree species like *ximenia americana, tamarindus indica, ficus vasta adansonia digitata, olea africana,* etc. are endangered. The loss of vegetation cover is at the centre of genetic erosion in the country. Forest cover has decreased drastically in the last century falling from about 30 % in 1880 to 20% in 1930; this figure further deteriorated to 11% in 1950 and 5% in 1960, hitting an ever low record of 2.03% in 1986. Woodlands accounted for another 11.3%. Recently, vegetation regeneration has occurred in many parts due to protection (closures) and tree planting. In 1999, 191,657 hectares, or 1.6% of the total area of the country, were under closures. Again by 1999, close to 54 million tree seedlings had been planted.

Fauna

Eritrea possesses various types of fauna. The study done so by the Department of Environment has identified 130 species of mammals, 528 species of birds, 109 species of reptiles, and 10 species of amphibians. The loss of forest cover, unregulated hunting, recurrent drought and long years of war led to the disappearance and/or migration of wild life. The prominent types of terrestrial fauna include various types of antelopes, ostriches, baboons, hyena, jackal, fox, leopard, elephants, wild ass, various types of reptiles and birds. Some mammal species like, *capra walia, and therphithecus gelada*, have become extinct while others like *gazella rufurons tilonoura and equus africanus* are endangered species. At present the main areas of wildlife concentration are the Gash-Barka lowlands and the red sea coastal plains.

There are also numerous marine fauna in the coastal and marine water of the Red Sea. The unique geo-chemical environment of the Red Sea and its islands provides a special situation for speciation and endemism. The Red Sea is rich in marine fauna, but it is particularly noted for its endemic species of coral genera. Of the total 53 coral genera found here, 49 or 92.5% are endemic while of the 1,248 fish species found here, 171 or 13.7% are endemic, but it may be as high as 50% for certain fish species. Other types of marine animals include molluses, shrimps, lobsters, sharks, turtles, dugongs, cetaceans, sirenians, pinnepeds, sea birds, sea grasses and other mangrove-supported biodiversity.

In Eritrea's exclusive marine economic zone, more than 250 species of reef fish from 49 families and 110 marine and shore bird species from 41 families have been recorded so far. As most of islands of Eritrea are not settled, they have good environment for nesting by various types of birds. Some of the birds observed in the Dahlak islands and other islands are the Grey Heron (*Ardea cinera*), Red Billed Tropic Bird, Reef Heron (*Egretta gularis*), Curlew (*Numenius arquata*), Black-winged Stilt (*Himantopus himantopus*), Greater Flamingo (*Phoenicopterus rubber*), Pelican (*Pelican rufesceens*), Osprey (*Pandion haliaetus*), etc. Passage migrant birds also visit the Dahlak Islands. The Dahlak Archipelago is the main breeding ground for green turtles and dugongs.

5.3 Socio-economic Environment

5.3.1 Socio economic facts of Asmara

Asmara is the capital city and economic centre of Eritrea with estimated population of 450,000. It is located on the central highland plateau at about 2,400 meters (7000 feet) above sea level. The total number of households inhibiting Asmara is estimated at 82,000.

According to the 1996/97 Eritrean Household Income and Expenditure Survey[3] (EHIES, 1997) the average yearly income of households in 12 urban areas was 12,000 ($1667) implying that per capita income was US$ 400 per year, twice the national GDP per capita of around $200. This income level in urban areas ranks Eritrea among the poor countries in Africa. Incomes in the capital Asmara, which averaged nearly 15,000 Nakfa, is twice as high when compared to the smaller highland and western lowland towns.

The higher economic incomes in the form of wages/salaries, self-employment, property, and transfer are clearly indicated in the capital city than in other urban towns as shown in the table below. That is, the annual household incomes of Asmara excel the average annual urban areas income in all forms of income sources. The highest discrepancy is shown particularly in the Property Income, which is 47% higher and in Total Transfer Income, which is 33.24 % higher than that of Total Urban.

	Asmara	Total Urban	% Diff.
Total wage income	4,628	3,991	15.96
Total self employment income	2,327	1,976	17.76
Total property income	3,434	2,325	47.70
Total transfer income	4,574	3433	33.24
Gross Annual HH income	14,963	11,725	27.62

Source: - Eritrea Household Income & Expenditure Survey (EHIES, 1997)

More over, the annual total household consumption expenditure in Asmara, which is 15,845, is by far greater than the average total urban of the country 12,427 Nakfa. In comparison, the annual household consumption expenditure in cash of Asmara is 20% higher; Housing Consumption Expenditure is 49% higher; and Other Consumption Expenditures are 23% higher than the Total Urban Areas.

Average annual household outlays by region in Nakfa

	Asmara	Total Urban	% Diff
Consumption Expenditure in cash	10,402	8,646	20.31
Housing consumption in Kind	4,520	3,031	49.13
Other consumption expenditure	923	750	23.07
Total Consumption expenditure	15,845	12,427	27.50

Source: - Eritrea Household Income & Expenditure Survey (EHIES, 1997)

[3] The survey covered 12 urban areas covering 115,000 households, with Asmara accounting for 58%, other highland towns 25%, western lowland towns 6%, Assab 6% and Massawa 4%.

Energy for cooking, lighting and heating is the fourth highest household consumption expenditure in all urban areas, after food, housing costs and clothing and footwear. Energy consumption that does not include for transport purposes amounted to 6.6% of the total household consumption expenditure in Asmara and 6.8% for all urban. In another study (Semereab and Zemenfes, 2001) it was found that Asmarans consume 14% of their income on energy, while the national average was 13.4%. However, in monetary terms the average annual household consumption expenditure for energy in Asmara is 23% higher than the total urban areas.

Average annual household consumption expenditure by main commodity group

	Asmara	Total Urban	% Diff
Food	5,028	4,494	11.88
Housing costs	5,474	3,752	45.90
Clothing & footwear	1,510	1,153	30.96
Energy for cooking and heating (Electricity)	1,044 (353)	849 (266)	22.97 (32.71)
Others	2,789	2,179	27.99
Total	15,845	12427	27.50

Source: - Eritrea Household Income & Expenditure Survey (EHIES, 1997)

With regard to the level of educational attainment, Asmara, the most urbanised area in the country, has the highest proportion of males & females with some education (88 percent & 77 percent respectively), which is significantly higher compared to other urban areas (80 percent and 70 percent respectively) according to EDHS 2002.

Around 37 percent of the urban households in Eritrea, own the house they live in, more in the Western Lowlands and in the Highlands outside Asmara than in the larger towns. Whereas, in Asmara 48 percent rent in private market. The majority of the households in the lowest quintile[4] in Asmara rent their dwelling in the private market and only 6 percent of them own their house, as opposed to 62 percent of the HH in the top quintile owning their house (EHIES 1997).

A socio economic assessment task for the Asmara Power Distribution component was given to Wekita Consultant whose objectives were:

- To assess the potential economic impacts of voltage conversion from the old 5.5 KV/127/230 to the more advanced and suitable system for industrial/commercial use of 15 kV/230/400;
- To assess the already effected voltage conversion in the City of Asmara with regard to needs of rewiring of in-house electrical installation;
- To assess sites of Asmara planned for conversion with regard to the preparations customers need to make before voltage conversion.

The consultant interviewed 116 households and firms, 46.5 percent were from the non-converted areas while the other 53.5 were from the converted areas. The sample included households from upper, middle and lower income groups. 80 percent of the sample was composed of households and the remaining 20 percent of industrial, commercial and other

[4] Households are ranked by the size of their income, and therefore divided in five equally large groups or quintiles, each containing 20% of the population.

general business The respondents were selected randomly from the streets of the residential areas or when they come in shops to buy.

The Process of Voltage Conversion
About 48 percent of those who converted say they were notified before voltage conversion, while 36 percent say the opposite, 3 percent do not remember, and the remaining 13 percent knew about it through personal inquiry. Almost all of the first groups, 97 percent, say that EEA has worked according the plan.

About 60 percent of those who have converted say that the process of conversion took less than a month, about 34 percent 1-2 months, the remaining 6 percent don't exactly remember. About trial test after conversion, 61 percent say that trial test have been conducted, while the other 39 percent say that there was no trial test.

When the respondent were asked to compare the result of conversion relative to their previous experience, about 77 percent believe the quality of the service improved, 19 percent did not perceive any difference, and the remaining 3 percent say the service got worse.

Rewiring can be a significant cost of the conversion process. From those who did the conversion, about 55 percent did not require rewiring, while the remaining 45 percent did require it. At the present time the cost of rewiring is estimated Nfa 400 per room on average.

About one third of those who converted electric voltage have experienced damage to some appliances after voltage change. Even though, the majority, two third did not experience damages, the 1:3 damage is significant. It is a burden to the clients. The causes of the damages, at least from the perception of the respondents, in the majority of the cases it is the fault of EEA (47.4%). The next major cause of damage is the negligence, lack of knowledge from the side of the user or family members of the client (42.1%).

5.3.2 The Rural Project Areas

To have a clearer understanding of the socio-economic environment of the rural areas targeted for electrification under this project, Wekita Consultants were employed to conduct the study and the following is an excerpt from its report.

The Context of the Study
The reason for including a socio-economic study as a part of the project was to ensure that various groups, including women and other vulnerable groups, were to benefit from the output of the project.

The primary beneficiaries of the project will be people living in the three rural areas, who are expected to benefit from the availability of an improved water supply through electrical pumps, lighting in their houses as well as an improved environment. They will most likely enjoy improved facilities for cooking, refrigeration, communication, commerce and small-scale industry as well as agricultural production. Beneficiaries of the project can also be men and women employed as casual labourers. However, in many cases, economic activity is constrained by other factors other than electricity supply, for instance, the availability of capital, credit, markets and skills.

As mentioned above, in rural areas, biomass fuels, wood and kerosene are normally being used for cooking, while kerosene and, to a lesser extent, candles or open fires are used for lighting. In reality, the majority of rural households live in darkness for about 11 hours per day. This makes mornings early and active and evenings idle and limits socio-economic activities, such as literacy training, other educational attainment, and participation in associative life or income generation practices. In addition, the collection of fire-wood is a heavy burden for men and women, who need to cover longer and longer distances, in order to provide for the needs of the household and often spend more than 5 hours a week on this task.

Lack of energy also puts a limitation to developments in other priority areas, such as water or agriculture. As concerns water, the drinking water supplied in villages are often from untreated surface water catchments or a shallow hand dug well, making waterborne diseases widespread. It is not uncommon for women to travel 5 km, on foot, every day, to fetch water. Rural electrification has thus a big potential to ease the heavy workload on women, who in addition to the above tasks, take care of the children and the elderly, cook and participate in agricultural production. It should be mentioned, that injera stoves, using electricity, have been development and are being used in some urban households.

As such, the electrification of rural areas is a development issue and a high priority on the agenda of the Eritrean Government. In addition it is an environmental issue related to the negative consequences of deforestation, soil fertility degradation and dwindling natural resources.

The Objectives of the Study

More specifically, the aim of the study was, in relation to the rural electrification project, to identify and evaluate a) the local priorities and needs, b) the possibility for different social groups to meet the costs associated with electric power supply and c) the importance of electrification for the rural communities. The study intended to gather information, making it possible to analyse, to what extent the project will benefit the local population and stimulate rural development. The main objectives of the study, according to the Terms of Reference were as follows:

- To analyse the social and economic situation in the local communities and identify how power supply can be effective in improving the living situation for different socio-economic groups in the area;
- To identify existing gender roles and needs and assess the implications and benefits of electric power supply for women and men;
- To address the issue of supplying electricity to rural low income households;
- To involve the local community in analysing and identifying the importance, need and possibility of electricity distribution in rural areas.

Study Methodology

i) In-depth interviews

In order to collect socio-economic data and information on the areas of study, this study has conducted in-depth interview with various officials. A group of five people from each site of study has been taken. The key informants have been selected with the help of the local administrators. The administrator was part of the group of informants.

ii) The Household Survey

The sample consisted of 50 households (30 from semi-urban and 20 from a typical village) each in the Dekemhare, Adi Keih, Keren and Barentu areas. An effort was made to have an equal representation of men and women as respondents. Both rich and poor households were included in the sample. About 30 percent of the respondents were female-headed households. In the survey, the sample was stratified in such a way that various vulnerable or priority groups were represented; Female Headed Households (FHHs), returnees and demobilised fighters and men as well as women.

The village/town administration helped identify the people to be interviewed. All group discussions took place in the villages/towns. All interviews were held in Tigrinya, following a semi-structured interview technique. Care was given to identify any gender differences, in the opinions related to the future use of electricity. It was also of particular interest to find out whether or not various groups would be able to afford the electricity connection and user fees, which is discussed in later sections.

Findings of the Rural Area Study

General Information on the Areas

The study comprises four areas: Dekemahare (Korbaria -village and Gaden - semi-urban)), Adi Keih (Quaatit - semiurban and Awhune village), Keren (Halhal semi urban and Hdish Adi - village), and Barentu (Areda - village and Mogolo - semiurban). The first two areas are located in the highlands of the country. Dekemhare area has a predominantly Christian and Tigrinya speaking population, while Adi Keih area is inhabited by Christians and Moslems, Tigrinya and Saho speaking people. The other two, Keren and Barentu areas, are located in the lowlands of Eritrea. The Keren areas are a mixture of Christians and Moslems who speak Tigrinya, Tigre and Bilen, while the Barentu area people are a mixture of Moslems and Christians, with small groups of animists. They speak Kunama, Tigriyna, Arabic, and Tigre. The population profile of the sample area is provided in Table 5-1 and the major socio economic characteristics in Table 5-2.

Table 5-1 Population of the sample areas

Population & Household	Dekemhare		Adi Keih		Keren		Barentu		Total
	Korbaria	Gaden	Quaatit	Awhune	Halhal	Hadish Adi	Areda	Mogolo	
Population	3435	1,190	2,930	1,680	6,800	1,450	1,500	3,500	22,485
Household	687	238	300	485	1,280	320	300	682	4,292
Sample	20	30	30	20	30	20	20	30	200
Permanent	19	28	24	20	25	20	7	15	158
Resettled/ Returnees	1	2	6	0	5	0	13	15	42

The villages covered by the project are located in the vicinity of main roads and are adequately served in terms of road transport, including bus services to main towns.

Table 5-2 Major Socio-economic Characteristics of Respondents

Characteristic of Respondents	Dekemhare				Adi Keih				Keren				Barentu				Total	
	Korbaria		Gaden		Quaatit		Awhune		Halhal		HadishA		Areda		Mogolo			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
MHH	12	60	22	73	24	80	13	65	26	87	17	85	11	55	17	57	142	71
FHH	8	40	8	27	6	20	7	35	4	13	3	15	9	45	13	43	58	29
Permanent residents	19	95	28	93	24	80	20	100	25	83	20	100	7	35	15	50	158	79
Resettled &Returnees	1	5	2	7	6	20	0	0	5	17	0	0	13	65	15	50	42	21
Christian	20	100	22	73	26	87	20	100	3	10	20	0	0	0	11	37	122	61
Moslem	0	0	8	27	4	13	0	0	27	90	0	0	20	100	19	63	78	39
Own farm	19	95	16	53	22	73	20	100	25	83	19	95	16	80	18	60	155	78
Own house	14	70	27	90	20	67	20	100	28	93	19	95	20	100	23	77	171	86
Access to credit	5	25	10	33	8	27	3	15	21	70	13	65	5	25	16	53	81	41
Informed on electrification	20	100	29	97	14	47	19	95	23	77	12	60	7	35	17	57	141	71

With the exception of the Kunama, Barentu area, that follow the matrilineal heritage, all the rest follow patrilineal lines and traditionally males do have a dominant influence or power on economic and social decision making. Women are mainly confined to household activities and participation in village assemblies or Baitos is very much limited, hence they have a very limited chance to influence the major social and economic decision of the village life. Government officials, to a large part, consist of former fighters and can be described as dedicated, gender aware and gender sensitive.

In general, fertile agricultural land is scarce in the highlands of Eritrea, in particular in the Keren area, while the agricultural land in the lowlands of Barentu is relatively fertile and bigger. The land is traditionally owned by men. Women play an important role, however, in cultivating the land and mainly in weeding and harvesting as well as in looking after poultry and smaller cattle. The population mainly lives on subsistence rain-fed agriculture. The average land-holding of a household is 1 hectare. In Dekemhare, Adi Keih, and Keren areas, while in the Barentu it can be bigger than one hectare.

The highlands and the Keren areas are mountainous, with difficult arable conditions on Hillsides. Terracing and tree-planting activities through Cash for Work Programmes and the National Development Campaign programmes are trying to reverse a history of extensive soil erosion. Women are active and often the dominant participant in Food for Woks Programmes.

During the past Ethiopian Administration, the agricultural production was severely disturbed, resulting in a substantial reduction of the livestock population and a reduction of crop production. No real forests (only shrubs) are left in the areas and the cutting of live trees is now forbidden. But it is still difficult to control deforestation because people are depending more and more on it for survival including the selling of wood and charcoal. Moreover, in the riverine areas large areas of woodland is being cleared for agricultural purposes. The recent border war with Ethiopia has also aggravated the felling of trees for military use.

Most of the people, 71 percent, are aware of the impact of electrification and had prior information about electrification. This indicates that people in these rural areas are going to

cooperate in the electrification project and it is a positive factor in the acceleration and success of the project.

Income and Expenditure

The basic annual household income is predominantly from agriculture. Grain, cattle, vegetables, eggs and milk are sold in order to be able to buy basic necessitates, such as soap, clothes, sugar and coffee. In addition to income from agricultural activities, it is common to have some small, often informal, business activities as a side activity.

The population in the areas of the study depends for their living mainly from the traditional agriculture. But there is a considerable variation among the various study sites. Agriculture as a source of income can be as low as 37 percent in Quaatit, while in Awhune and Korbaria as high as 80-85 percent. Those who live on wage/salary income are about 18 percent on average, but we observe that Quaatit is the highest with 30 percent followed by Korbaria, Gaden, and Areda with 20 percent each. Those who live on business only are about 9 percent on average with Mogolo the highest 23 percent. Those who live on both agriculture and wage or salary are about 20 percent on average, but Gaden has the highest with 63 percent followed by Korbaria with 45 percent. On average, those who live on agriculture and business are about 10 percent, and finally those who live on agriculture and remittance are about 5 percent (see Table5-3).

The result of the survey indicates that the average annual income in the study sites is between Nfa 2,119 (Awhune) and Nfa 19,285 (Mogolo). The average annual expenditure ranges from Nfa 3,716-5,703. The average expenditure figures were substantially higher at the lower end of the range while they are lower at the upper end. We explain the differences by a general uneasiness in disclosing the full amount of money earned and remittances from relatives (see Table5-4).

Table 5-3 Sources of Income of Respondents

Income Source	Dekemhare				Adi Keih				Keren				Barentu				Total	
	Korbaria		Gaden		Quaatit		Awhune		Halhal		HadishA		Areda		Mogolo			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Agriculture	16	80	15	50	11	37	17	85	12	40	12	60	11	55	12	40	106	53
Business	0	0	3	10	4	13	0	0	1	3	0	0	2	10	7	23	17	9
Salary/wage	4	20	6	20	9	30	0	0	5	17	2	10	4	20	5	17	35	18
Agriculture +Business	2	10	0	0	1	3	1	5	4	13	3	15	4	20	5	17	20	10
Agriculture + Wage/salary	9	45	19	63	2	7	2	10	4	13	2	10	0	0	2	7	40	20
Agriculture + Remittance	0	0	0	0	3	10	1	5	4	13	1	5	0	0	0	0	9	5

Table 5-4 Annual Income and Expenditure of Households and Energy Expenditures

Income & expenditure	Dekemhare		Adi Keih		Keren		Barentu		Range
	Korbaria	Gaden	Quaatit	Awhune	Halhal	HadishA	Areda	Mogolo	
	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	
Income	7,875	6,533	3,967	2,119	4,328	4,500	8.186	19,285	2,119-19,285
Expenditure	5,338	4,052	4,329	3,357	4,864	4,898	3,902	5,893	3,902-5,703
Energy(HH)	885	1,688	444	210	760	431	385	767	210-1,688
Energy(Bus)	5,190	12,000	840	0	2,612	11,640	4,932	956	840-12,000

Households are spending between 10 to 20 percent of their income on energy needs (national average being 14%. We observe that households expenditure on energy ranges from Nfa 210-1,688, while that of energy for businesses ranges from Nfa 840-12,000 (see Table 5-4).

Present Workload of Men and Women

In addition to agricultural activities, household work, such as collecting firewood, fetching water and cooking is demanding and time-consuming and limits the available time for productive activities.

As an example, households in the study sites spend, on an average, 8-27 hours per month on collecting firewood. This is man's task, when the wood is collected from far away and with the help of a donkey and a women's task when smaller quantities are collected from close by. In some villages men have to go for 2-3 days to collect wood, i.e. about 72 hours per month. Also obtaining alternative sources of energy, such as kerosene, is a time-consuming venture and the households spend between 0.5-15 hours per month.

Table 5-5 Time Spent in Collecting Firewood (Hour/Month)

commodity type	Dekemhare		Adi Keih		Keren		Barentu		Range
	Korbaria No. %	Gaden No. %	Quaatit No. %	Awhune No. %	Halhal No. %	HadishA No. %	Areda No. %	Mogolo No. %	
Firewood	10	15	10	27	10	8	15	20	8-27
Kerosene	4	15	0.5	5	2	2	8	8	0.5-15
Water	15	30	10	10	10	10	10	10	10-30

The most time-consuming household tasks after cooking, is fetching water and this is a task primarily carried out by women and children. The households in this study spend between 10-30 hours fetching water (see Table 5-5). None of the areas have been electrified and the only electricity presently available stems from individually run generators serving income-generating activities.

Basic Infrastructure and Services

Some commercial and business establishments especially water pumping for irrigation have their own pumpsets and/or gensets. Some social services like health centres, village water points, schools and churches/mosques have their own generators through gensets or solar PV systems. The main source of energy for the households is fuel wood. Men collect the wood when it is far away and women/children when it is close by. Women are also responsible for the collection of cow-dung for fuel. In most of the villages water supply is from hand-dug wells, some have pumps, others are open and served through ropes and buckets. The national picture of energy and water supply services as established in the 2002 Eritrean Demographic and Health Survey (EDHS, 2002) is provided in Table 5-6 below.

Health and nutrition. In 1999 life expectancy at birth in Eritrea stood at 50 years, slightly above the Sub-Saharan African average of 47 (reflecting the high rate of death from AIDS in some countries of the region), but well below the average of 59 years for other low-income countries. Children suffer from poor nutrition. About 38 percent of children in Eritrea under five years are stunted (low height for age), 15 percent are wasted (low weight for age) and 44

percent of children are underweight. Nearly 50 percent of children suffer from anaemia. Maternal mortality at 1,000 deaths per 100,000 live births due to complications of pregnancy and childbirth is double the average for Sub-Saharan Africa and among the highest in the world. Infant mortality has declined from 72 per 1,000 live births in 1992 to 48 in 2002. Mortality of children under five years declined from 136 per 1,000 live births in 1992 to 93 in 2002. Although these are encouraging trends, a great deal needs to be done to further reduce Eritrea's mortality and morbidity rates, particularly those involving children and women.

Education. Considerable progress has been made in bringing primary school education to the citizens of Eritrea. At independence, it was estimated that only about 58 percent of men and 28 percent of women could read and write. By 1999 it was estimated that 67 percent of men and 39 percent of women were literate. Currently the gross primary school enrolment rate stands at 53 percent for boys and 49 percent for girls. However, repetition and drop out rates are high, especially of girls. Girls are much less likely to attend and complete secondary school than boys, and fewer still attend the University of Asmara or other institutions of higher education.

There are significant regional variations in access to health and education services. Households living in the highlands, and especially in the cities, are much more likely to visit health facilities and send their children to school than those living elsewhere. Asmara, with 15 percent of the nation's population, has both the largest number and the highest quality of schools and health care facilities. A higher proportion of women living in Asmara receive antenatal care and give birth in hospitals, and a higher share of children are monitored for growth and attend school than elsewhere. As a result, maternal mortality, child mortality and child malnutrition are lower in Asmara than in other places, and school enrolment (especially of girls) is higher. Highlanders not living in the cities are still able to access services more readily than rural dwellers in other parts of the country. This is because more facilities per square kilometre have been provided there, due to the region's greater population density. Therefore, most families in the highlands live closer to schools or health care facilities than ones elsewhere, and their travel times and costs are lower. The long distances to health facilities and schools in lowlands discourage many people from benefiting from the services.

Table 5-6 Percent distribution of households by household characteristics, according to residence

	Urban				
Characteristic	Total urban	Asmara	Other Towns	Rural	Total
Electricity					
Yes	78.3	98.7	60.9	3.0	32.2
No	21.7	1.3	39.1	96.9	67.8
Total	**100**	**100**	**100**	**99.9**	**100**
Sources of Drinking Water					
Piped into residence/yard/plot	41.9	56.9	29.0	0.1	16.3
Public tap	25.1	15.1	33.8	18.1	20.8
Unprotected well in dwelling/ yard/plot	0.1	0.0	0.2	0.6	0.4
Unprotected public well	2.1	0.0	3.9	24.7	15.9
Protected well in dwelling/ yard/plot	0.3	0.0	0.5	0.4	0.4
Protected public well	4.2	0.2	7.6	26.3	17.8
Spring	0.3	0.0	0.6	17.2	10.7
River, stream	0.2	0.0	0.3	4.8	3.0
pond, lake	0.1	0.0	0.1	1.4	0.9
Dam	0.1	0.0	0.2	2.3	1.5
Tanker Truck	25.5	27.7	23.6	3.8	12.2
Total	**100**	**100**	**100**	**100**	**100**
Time to Water source					
minutes	68.7	80.9	58.3	8.2	31.6
Median time to source	0.0	0.0	0.0	59.7	29.9
Total	**68.7**	**80.9**	**58.3**	**67.9**	**61.5**
Normal wait at water source					
None	72.5	81.1	65.2	47.9	57.4
<5	0.4	0.6	0.3	0.0	0.2
5-14min	3.7	2.7	4.7	4.2	4.0
15-29min	5.4	3.1	7.5	7.8	6.9
30.44min	6.3	4.1	8.1	15.4	11.9
45-59min	0.6	0.4	0.7	0.7	0.7
60+min	11.1	8.1	13.6	23.8	18.9
Total	**100**	**100**	**100**	**100**	**100**
Sanitation facility					
Own flush toilet	23.0	32.3	15.1	0.4	9.1
Shared flush toilet	18.8	29.6	9.5	0.3	7.5
Transitional pit toilet	15.6	8.4	21.7	1.3	6.8
Ventilated improved pit latrine	3.2	2.7	3.6	1.5	2.2
No facility, bush, field	39.4	27.0	50.1	96.4	74.3
Others	0.0	0.0	0.1	0.0	0.0
Total	**100**	**100**	**100.1**	**99.9**	**99.9**
Fuel used for cooking					
Gas	11.9	21.9	3.3	0.2	4.7
Electricity	1.6	3.0	0.4	0.0	0.6
Kerosene	58.2	70.3	47.9	8.9	28.0
Charcoal/coal	3.0	0.4	5.2	0.9	1.7
Wood, straw	23.4	3.0	41.0	82.1	59.4
Animal dung cakes	1.2	0.8	1.5	7.7	5.2
Others	0.5	0.4	0.6	0.1	0.2
Missing	0.2	0.3	0.1	0.1	0.1
Total	**100**	**100**	**100**	**100**	**100**

The Private Sector

In the study areas, there are more than 1300 business enterprises. With the supply of electricity, these businesses plan to expand production as well as employment. In the Gaden area alone there are over 300 irrigated horticultural farms using pumpsets and or gensets. In another study (Semereab and Zemenfes, 2002) 43 farmers were sampled and visioned various opportunities in grid electrification: -

- Workshops and garages might be opened in Gaden, and this will save them the trouble of transporting pumpsets to Asmara or Dekemhare for repair and maintenance. Delays in repair and maintenance of pumpsets could lead to severe deterioration of farms, particularly if such delays match with periods of peak crop water demand.
- They can use submersible or vertical electric pumps, and this will save them the trouble of going down deep wells every time.
- With electricity, they only need to extend electrical wires if they have to use more than one motor.
- Electricity can help them diversify their sources of income by making sideline activities possible. In fact it was observed that some farmers with gensets had such activities in the form of poultry, for example.
- Electricity might facilitate appropriate storage for some perishable products like tomatoes and papaya, which are susceptible to damage due to high temperatures of the area.
- Electrification will enhance the position of Gaden as a growth centre, and it could attract more enterprises creating job opportunities for people.

At the present time, many of these businesses are working below capacity due to an insufficient supply of energy. 100 percent of the respondents agree the electrification project is expected to change completely the life of these rural people. Most of the people, more than 90 percent, expect a considerable time saving at work. From 40-95 percent are expecting to expand production, some 43-65 percent to start new businesses, while some 30-60 percent will be employing additional workers. All of these show that electrification will result in stimulating development of the rural economy of the country (see Table 5-7).

Table 5-7 Impact of Electrification in the Life of the People (%)

The change brought	Dekemhare		Adi Keyieh		Keren		Barentu		Range
	Korbaria	Gaden	Quaatit	Awhune	Halhal	HadishA	Areda	Mogolo	
Change our life	100	100	100	100	100	100	100	100	100
Time saving at work	100	100	33	90	100	100	95	100	33-100
Expanding production	85	90	80	95	87	75	40	60	40-95
Plan to start new production activity	60	57	57	45	63	50	65	43	43-65
Additional workers	55	57	50	30	57	100	60	53	30-100
Children at school	51	54	63	87	65	60	51	46	46-87

Credit

There are several NGO and Government organisations that provide credit to the rural population. To mention some, Rural Enterprise Unit, ECDF's Rural Credit and Savings Village Banks, SELF HELP and ACORD, are supporting rural micro credits. Rural people in general used to be suspicious of loans, but this is changing fast in the past few years and

people have started to understand their use. It is fair to assume that people would avail themselves of the credit opportunities offered to them.

Preparedness for electrification

One of the main obstacles of rural electrification is how to make it affordable and sustainable. With most people living below USD 200 per year per household, it is a big problem indeed. Can the rural people in the project area afford to pay for electric services? The survey asked specifically these question, and to our surprise we found encouraging answers. The respondents were specifically asked their willingness to pay for connection from nearest pole, in-house installation, monthly consumption, and electric meter connection costs. Their readiness to afford for electricity services ranged from Nakfa 127 to 451 for connection, Nfa 74-213 for in-house installation, Nfa 50-221 for monthly consumption bill, and Nfa 383-605 for own-use of electric kWh meter. But with regard to meter connection about 50 percent said they rather share the meter with their neighbours as they cannot afford to have one on their own. Most of the existing socio-economic groups will undoubtedly avail themselves of the opportunity to have access to electricity. About 96 percent have said they have the capacity to meet the electrification costs, but there are a small group, 4 percent, who categorically said they cannot meet the electrification costs. Of course, the most vulnerable groups might not have the necessary means to meet the cost of electricity services. To avoid their exclusion, the Government and NGOs should find some fund to assist these groups of households. In particular, institutions active in poverty alleviation programs should give a particular attention to it for it offers an opportunity to change their life.

Respondents were also asked about the sources of finance from which they plan to meet the electric service costs. It was found that 50 percent would meet the costs from agricultural income, 19 percent from wages and salaries they earn outside agriculture, 24% from petty trade income, 4% from remittance and 3% from micro-credit organisations.

Income from agricultural activities is expected to increase through improved storage and processing facilities. There is also a good potential for replacement of diesel-powered pumpsets and gensets for irrigation. Farming activities will thus, generally benefit from this project. As per the survey results the intended use of electricity is provided in Table 5-8.

Table 5-8 Use of Electrification

Electricity used for	Dekemhare		Adi Keih		Keren		Barentu		Total No. (%)
	Korbaria No. %	Gaden No. %	Quaatit No. %	Awhune No. %	Halhal No. %	HadishA No. %	Areda No. %	Mogolo No. %	
Cooking	14(70)	25(83)	17(57)	15(75)	13(43)	11(55)	-	7(23)	102(51)
Income generation	9(45)	16(53)	10(33)	3(15)	-	1(5)	-	7(23)	46(23)
Agriculture	6(80)	12(40)	-	4(20)	2(7)	-	-	1(3)	25(13)
Lighting & Entertainment	20(100)	30(100)	24(80)	20(100)	13(43)	11(55)	14(70)	26(87)	158(79)
All of the above	8(40)	10(33)	6(20)	1(5)	17(57)	9(45)	6(30)	5(17)	62(31)

Expected Results of Electrification in the Areas of Study

Distribution Effects

The basic connection fee, for private households, is estimated by EEA at Nfa 350 but will depend on how for the household is far from the source. A household in a remote location, in a village, is likely to have to pay more. The registration fee is Nfa 50.

The majority of the population in the study areas are expected to be able to pay the Nakfa 350 needed to cover the installation fee, but our survey indicates that the people cannot meet this cost for they said they can afford between Nfa 74-213 only. It is therefore proposed that people in this area should be able to pay in instalments over 2 years instead of 1 year. This way, they will be able to take advantage of two harvests.

We would like to recommend the Government and Donor Agencies to establish a revolving fund for this purpose. This fund once refilled through repayments, could be used for rural electrification projects in other areas of the country as well. The needed size of this fund is about 1 million Nakfa, which would enable about 3 000 people, to access an amount of Nfa 350. With such a fund it is fair to expect that at least 50 percent of the population in the project areas to benefit from the electrification project.

The poorest strata of the population will probably not have the possibility to connect to the electrical distribution system but will, nevertheless, benefit from the project through the availability of street-lighting and improved health, education and water services and related installations or by connecting through their neighbours. There are also expected multiplier effects through an expansion of the economy, which will create employment opportunities, which should also benefit the poor.

It is also important that the project is designed in such a way that the more remote and often poorer households will be given an opportunity to benefit and not be punished by relatively higher connection costs. It is possible that villages will organise themselves and collect the same connection fees for everybody and maybe even subsidise poorer members of the community. Villages usually have a development fund, a kind of voluntary tax system, which can be used for this purpose. For others, the establishment of a revolving fund, as suggested above, could be the solution.

Electrification Costs and Affordability

About 96 percent of the respondents in the study areas were of the opinion that they could afford to meet the electrification costs. The range of capability goes from Nfa 127-451 for connection costs, Nfa 74-213 for installation costs, Nfa 50-221 for consumption per month, and 383-605 for electric meter. These costs would normally be financed from agricultural activities (50%), wage/salary (19%), or other income generating activities (24%), and in the remaining cases from remittance (4%) or credit (3%).

When it comes to the monthly consumption cost, estimated at about Nfa 15, for lighting only, it is not seen as a problem but rather that the majority of the households interviewed would be able to assume this. Most of the people in the study areas said they can afford to pay between Nfa 50-74 per month.

The study showed that in male-headed households; decisions about expenses were primarily made by the men. This will not, however, cause a problem for the electrification project, since there is a very high degree of consensus between family members of the usefulness of electricity.

Cost of Electricity and Electrical Household Items

The households taking advantage of the possibility of electrification will have/want to equip their houses with necessary items, example of such items and the prices are give below:

	In Nakfa
Fluorescent tube	80.00
Switcher	11.00
Electric bulb	5.00
Hot plate	90.00
Injera oven	1,500.00
Small stove	250.00
Small stove with oven	1,700.00
Refrigerator	3,000.00

To get wires and switches etc., into the house, will be about Nfa 100-200. The majority of the people in the areas will only use electricity for lighting and will not have to assume any major investment in equipment or products. The use of electric injera stoves is not encouraged by the EEA because this would put heavy demands on the system, and at the same time during the day. In addition, these items are expensive and out of reach for a large part of the population in the areas. The houses, except those with thatched roofs, themselves seem relatively safe for electricity installation, but will need to be inspected.

Usage of the Electricity

The large majority of the respondents, 79 percent, indicate that they would solely use the electricity for lighting and entertainment (radio, TV, tape recorder, and other similar), 23 percent for income generating activities, 13 percent for agricultural activities, 51 percent for cooking, and 31 percent for all possible uses. Women are presently the principal users of household energy in their role as cooks. The percent for cooking seems to be over estimated because the energy consumption will be higher and the cost as well. Electricity is not cheap to use for all types of cooking. Experience shows us that baking injera will be definitely electrified, but not the cooking of other food staff. Gas is frequently used as a source of cheaper energy as well as kerosene. It is not reasonable to expect rural people to discontinue the use of wood, charcoal, and cow-dung as cheap sources of energy. One reason is that they underestimate the cost of purchasing electrical products such as an injera-stove as well as the cost of electric consumption that accompany it. But with time and with greater economic development, it can be expected households to progressively use more and more of electricity and gas for cooking. For now, the first major use of electricity will remain for lighting and entertainment only. This is normal due to the low rural income.

Effect on the work-burden

The survey shows that in rural areas the work-burden of household are expected to decrease due to the access to labour-saving technologies due to electricity (electric grinding mills, pumps, stoves, electric mogogo etc.), which in particular will reduce the time for processing and preparing food. The living conditions (quality of household life) is expected to improve dramatically because there would be light and energy to make life easier. More than 90 percent of the respondents indicated that there will be considerable time saving at work. We find that in particular, the female respondents expect their domestic workload to decrease.

In urban areas, on the other hand, the work-burden is often expected to increase because people will venture into new income-oriented activities or expand existing ones. Examples given were keeping shops open longer hours, the opening of workshops and the women were intending to start knitting or sewing activities. Other envisaged income-generating activities are hairdressing, laundry services, bars and restaurants and metal and woodworking shops. Other advantages would be for students, who will be able to study for longer hours.

Effects on Industrial Production and Services
Many of the existing industrial companies are today working below capacity because of an insufficient supply of electricity. The generators, operated by fuels are not sufficient and in addition, not cost-effective. The present production is labour and time consuming, products are often not of the desired quality and there is a need for upgrading the technology, which is not feasible under the present circumstances. Electricity would also provide an incentive to start new businesses. The potential for growth is there and the industries can play an important role in providing needed employment opportunities.

For businesses in the service sector the effect is primarily on shops, bars and restaurants, which will be able to keep open for longer hours. 43-65 percent of the population in the study areas assume they will venture into new production-oriented activities, would there be electricity. The kinds of activities envisaged are; carpeting, tailoring, hairdressing, poultry and laundry services. It is expected that there will be a need for additional employees as a result of this development.

Effects on Agricultural Production
The electricity will, potentially replace small-scale gensets and pumpsets for use in agriculture. There is an expected increase in agriculture production due to the labour-saving effects, at the household level, of electrification, which will provide additional time to work in the fields or on other non-agriculture-oriented duties. Other possible benefits are food storage and drying facilities, refrigerators for dairy farms, the possibility of using electrical tools and equipment and the preservation of medicine for owners of cattle. In some areas, cattle herds will be able to take advantage of new water holes. New envisaged income-generating activities are poultry and horticulture.

Effects on Employment
The long-term effects on employment are expected to be substantial due to an expansion of the local economy through the establishment and expansion of various businesses. In the short term the project will offer men and women employment as casual labourers. In Eritrea, many women work in construction and there have been examples of construction sites with more female than male manpower. The EEA should give attention to having women employed as labour under the project.

The supply of electricity is expected to reinforce the development activities in the study areas. Many potential investors are waiting for electrification in order to start activities. The investment climate is regarded as favourable.

Gender Aspects
When it comes to priorities regarding the use of electricity, differences between men and women could be expected. However, while there are some differences they are not very marked. First of all, both men and women would like to have access to electricity and see this as a priority when it comes to allocation of financial resources. Both men and women, are of the opinion that the main advantage of electricity will be to facilitate domestic tasks. Asked about other benefits, social development comes in second place for both categories. This being said it is also obvious that women put more emphasis on the labour and timesaving potential of electricity and men on the potential for business development and agricultural development. Furthermore, women frequently mention the improvement of living and health conditions while men are more apt to mention new employment opportunities.

Health

First of all conditions at health-clinics and –stations will improve due to lighting and the possibility to use refrigerators to store vaccines and food. Another aspect is that the quality of water will improve with drilling facilities and electrical pumps. Finally, the electrification project has the potential to substantially improve the health of family members and, in particular, women, who are presently suffering from eye and respiratory infections, caused by constant smoke. Also the food intake is expected to be ameliorated through the increased possibility to cook various nutritious dishes and for cold storage.

Conclusions

This survey shows clearly that most of the people in the project areas under study are very eager to get electricity service very soon. 100 percent of the respondents expect electrification to change completely the quality of their life. About 96 percent think they can meet the costs of electrification.

All of them expect electricity will revive their economic development. 40-95 percent of respondents expect production expansion, 43-63 percent plan to start new businesses, and 30-60 percent expect to employ more workers.

Most of the people will use electricity for lighting and entertainment (radio, TV, tape recorder), 79 percent, 51 percent for cooking, 31 percent for possible uses, 23 percent for income generating, and 13 percent for agricultural activities.

There are about 29 percent that want to have their own electric meter, while other 51 percent are willing to share electric meter to reduce costs.

With regard to participating in the co-operatives for the electric administration of the village, the majority, 73 percent are willing while another 14 percent are not willing for various reasons. This is a very encouraging figure to the process of rural electrification.

All the facts lead us to conclude that the rural electrification project in the study areas can succeed. But for the initial costs of connection and installation some fund must be found to enable the people to pay in instalments.

6. POTENTIAL ENVIRONMENTAL IMPACTS

The construction and operation of the Asmara Power Distribution and Rural Electrification Project will lead to a variety of changes in the local and wider environment. Many of the effects will be beneficial, particularly the impact at the national level of increasing the availability of electricity, and the potential to develop the local economy through improved infrastructure and employment opportunities. There will nevertheless be some negative effects during the construction phase, most of those will be short-term. During the operation phase the management of rural electrification might pose a considerable problem for the EEA unless the local communities are mobilised to participate in its handling. Although the scale and magnitude of many impacts cannot be predicted accurately, their recognition at an early phase of the project development enables mitigating measures, where these are practicable, to be incorporated into the design and monitoring programmes to be set up to assess the need for remedial action. An awareness of the residual environmental implications of the project is also fundamental for a balanced decision to avert potential negative impacts.

This chapter identifies those areas where significant environmental and social effects are likely to arise from the various activities and requirements of the project, during both the 4 year construction phase and under operation.

Summary of Positive Benefits of the Project

The project will potentially have a number of beneficial impacts on the natural and the socio-economic environment, both during its construction and its operational life. The major positive benefits of the Asmara Power Distribution component will be the reduction of electrical losses by about 9% and the reduction in overall distribution operations and maintenance costs, inducing a lower cost of production per kWh of electricity. The reduction in technical power losses may be translated to the reduction of CO_2 emissions thus has global environmental benefit. The new generation facility at Hirgigo near Massawa is consuming around 170 grams of heavy fuel oil per kWh of electricity generated compared to the average consumption of around 220 grams of diesel or light fuel oil in the replaced old systems. If we estimate the 2003 generation to be around 300 GWh, the new facility will reduce CO_2 emissions by around 45,000 tons in that year.

To make the power systems more efficient and to promote energy conservation measures, major projects to rehabilitate the old transmission and distribution systems in Asmara and Massawa have been designed. The Massawa project has already entered in the implementation process while that of Asmara will start in 2004. When finalised, the current technical losses in transmission and distribution system will be reduced by at least 50%. Assuming that oil fired stations produce about 0.7 ton of CO_2/MWh generated, this reduction in technical loses implies CO_2 abatement of 21,000 tons/year. Other secondary benefits include better supply quality, less disturbances and outages, voltage drops will be avoided and/or maintained at acceptable levels, less connection costs for new customers, all of which will contribute to much better satisfied customers. Other positive benefits to the natural environment will be the reduction of visual intrusion by above ground distribution infrastructure in the Asmara City centre.

That of the Rural Electrification component, the major benefit will be the availability of the most preferred and versatile energy form, electricity, to motivate rural development. Substitution of kerosene lighting and diesel operated pumpsets and small gensets by electricity in the rural project areas will have global environment benefit. These extensions of grid electricity supply are expected to remove some of the energy-related barriers to sustainable development. Many income-generating facilities are expected to mushroom and existing ones strengthened. The large unserved needs for water pumping and lighting in rural areas will have electric options, and the over-utilisation of biomass fuel for cooking and heating which has led to degradation of the forests and soil fertility at an alarming rate will be reduced. The rural population will also be able to enjoy associated improved facilities for entertainment at home, refrigeration, electronic communications and services, small-scale industrial production, etc. In many areas, economic activity is constrained by factors other than electricity supply. The economic impact of electricity supply improvements may be limited in such areas, but access to electricity is expected to generate socio-economic benefits, which are important to households in these disadvantaged areas. As the positive benefits to the socio-economic environment by far exceed those for the natural environment, they will constitute the main focus of the discussions in this chapter.

Asmara power supply at present

A number of recent studies on the power sector in Eritrea have pointed to EEA's operational difficulties and severe constraints such as the utility's inability to provide reliable and quality customer services, power losses in the range of 15-20% and reduced earnings. Other problems relate to frequent power outages and voltage fluctuations, which have eroded consumer confidence. These weaknesses have not only translated into higher production costs for industrial producers and frequent damages to consumer durables, commercial and industrial equipment, but have become source of concern to prospective investors. A competitively priced and reliable power supply helps to create an attractive environment for investors.

From discussions held in energy related workshops with industry managers, representatives of government policy makers and the Business Community and the National Chamber of Commerce, it was evident and a unanimous view that economic growth in many sectors of the economy has been constrained by inadequate and unreliable supply of power, prior to the commissioning of the Hirgigo Power plant. The IVO Power/Electtrowatt (1998) feasibility study has concluded that businesses lost about 674 and 343 working hours in 1995 and 1996 respectively due to power cuts, load shedding and suppressed demand. This translates into a suppression of economic growth for the affected businesses of about 8% in 1995 and 4% in 1996. The planned and unplanned interruptions of power supply in the ensuing years 1997-1999 years are shown in Table 6-1 below.

Table 6-1 Supply Interruptions from EEA facilities 1997-1999 (Source: EEA Reports).

	Unplanned interruptions			Planned interruptions		
Year	Minutes	Days	kWh	Minutes	Days	kWh
1997	22263	15.5	368599	9405	6.5	89503
1998	34256	23.8	482725	21729	15.1	124857
1999	35758	24.8	522949	9419	6.5	95463

The supply interruption was 70% unplanned in 1997, 61% in 1998 and 79% in 1999. The supply interruption duration ranged from 528 hours in 1997 to 936 hours in 1998. This may

imply that as high as 10.7% of the year, e. g., in 1999, was without supply of electricity in the city of Asmara and its environs.

On the other hand, interruptions are much higher, typically 2-3 months of the year, in the rural and semi-urban residential areas or enterprises being served with gensets. As there is normally only one genset installed, breakdown is quite often due to poor repair and maintenance services. If such gensets become defective a specialist has to be called from Asmara (in most cases) or the genset has to be transported to Asmara (rarely) further prolonging the interruption period. Absence of spare-parts may even force the defective genset to be abandoned especially those purchased from unofficial local dealers of manufacturers. Such problems are indicators of uneconomic and unsustainable energy supply systems, which is prevalent in the rural areas. Considering the current Government and Donor focus on the reduction of rural poverty, rural electrification is a critical issue to be addressed.

Load Forecasts
Time series statistics of yearly generation and sales from EEA systems indicate (see Table 3.3) that power demand is growing nationally at a rate of 8 - 10% per year implying a demand growth of 5 - 6 MW per year as peak demand is currently estimated at 60 MW. IVO/Electrowatt and EEA planning engineers, taking into consideration the already known new construction programs in Greater Asmara like hotels, high rise office buildings industries etc., and using the experience from similar trends in other African countries, a load growth of 7% during the first 10 years, reduced to 4% during the following 10 years and reduced to 2% during the last 10 years period has been assumed for the Asmara Power Distribution Project. This implies a load growth of approximately 350% of the present load within the next 30 years of Asmara area development. The Greater Asmara includes 21 satellite villages and townships, all within 1-4 kms from the peripheries of the City Centre. These and further away villages (upto 30 kms) are being electrified at the moment from other financial sources, outside of this project. It is the Government's intention to locate the heavy industries (cement/ceramics, glass, refinery, etc.) closer to the coastal areas, where the transport, fuel and water supply problems can be easier solved than in Asmara area which is located in the highland.

As detailed engineering design is yet to be prepared by an international consultant, employment estimates for the construction and operational phases of the project cannot be estimated for this report.

6.1 Negative Impacts during the Construction Phase

A) The Power Distribution Project (Asmara Voltage Conversion & Rehabilitation)

The implementation of the project requires excessive excavation to lay under ground MV & L.V cables along the main highways and feeder roads. The erection of new MV/LV underground cable pathways erection will especially affect the urban pavements and road crossings. The depth of the cable pathways will be 80 cm and width 60 cm from as has been observed from the Massawa similar project. The overhead LV cables and street light poles will also require spaces for holes to pole erection mostly on the sidewalks. This shall cause a temporary disturbance to urban car traffic, cyclists, pedestrians as well as to residential buildings and business areas. Within a specific area all efforts have to be made to lay the cables with urgency and backfill of the excavated underground cable pathways immediately.

In addition, the city roads and pavements shall be dusty and dirty temporarily, until it is cleared by wind erosion or rainwater run-off. Great caution and care shall be taken to avoid the cutting of sidewalk tress and excavation of gardens etc., unless it is absolutely necessary. All excavations shall be repaired and be brought to their normal situation immediately after completion of each section in order to avoid inconveniences to Asmara City residents.

Among the anticipated serious environmental impacts during the excavation of underground cable pathways will be unintentional damages to underground water piping systems and telecom lines, and even buried cultural heritage sites as the Greater Asmara area is known for it. Every effort has to be made to involve the offices responsible during the selection and excavation of the underground electricity cable routes. These offices (for water and telecom) are already aware of the project and have expressed to co-operate in supplying the area specific maps for their covered systems. To avoid electromagnetic interference on the telecom lines, the regulation of the Department of Infrastructure of Asmara Municipality to lay main electricity and telecom lines on the opposite sides of the highways/roads shall be strictly followed (see section 2.4). In case the two lines meet during crossing of a road, effort shall be done for perpendicular crossing. Whenever telecom main line and electricity minor line (mostly supplying street lights) or *vice versa* share a pavement then they have to be laid on opposite ends of the pavement as per the referred regulation.

The present electrical medium voltage distribution system in the city of Asmara has primarily a **radial structure**. It has open wire 5.5KV overhead lines with relatively small conductor cross sections. Only in the inner city centre, 5.5.KV cables are utilised.

For conversion to a new voltage level of 15kv with minimal outages for the individual customers the radial structure is not optimal, because a complete feeder, or major parts thereof have to be disconnected during the upgrading of the MV lines. All critical consumers, like hospitals, government offices, sensitive industrial establishments, etc, would have to be supplied temporarily with mobile diesel generators, especially when they don't have back-up/stand by generators. The radial structure should be changed to a double fed loop structure. in such structure the lines and cables may be upgraded to 15kv section by section form one end, and the consumers could still be supplied by the existing 5.5kv line via the existing transformer station.

New mast-mounted transformer stations should be placed in the vicinity of the existing ones (may be utilising the reconditioned material from replaced stations). To achieve a consistent design standard of the converted 5.5/0.22KV mast – mounted transformers stations, it may not be advisable to upgrade the existing most-mounted transformer stations piece by piece, even if the transformer are already designed for voltage change, because the fuses and disconnectors need to be replaced or reconditioned as well. This would lead to unnecessary long outage times.

For refurbishing indoor transformer stations, temporary trailer-mounted substations, or new permanent type substations may be applied. In most cases space available inside is sufficient to install the new equipment while the existing equipment is in operation. Most transformer stations shall be indoors in compact setting to avoid spoiling the outlook of the city.

Low voltage overhead feeders should be completely replaced by Aerial Bundled Conductor cables (ABC cables) and connected to the new transformer stations. The existing open wire circuits are dangerous and the cross sections are much too small. Replacement of the

conductors only by insulated conductors of larger cross sections is slow and needs partial replacing of masts and insulators because of the higher mechanical loads. The construction of the low voltage system should be designed and implemented carefully to avoid human as well as animal electrocution during severe short circuits to earth.

Different construction crews are normally used for MV lines and transformer stations than for LV lines and installations. Therefore the new LV feeders and the house connection can be installed in parallel to the upgrading of the MV line sections and the installation of new transformer stations.

The **Socio-economic** impact of voltage conversion to consumers are enumerated below:-

a) A rather complicated "two meter system" (one for light and another for power for ordinary houses is being generally used at present in Asmara. During the low voltage conversion from the present 220/127 to the future 400/230 system single meters shall be installed. The consumers shall be responsible for the modification of their in-house wiring if necessary, in their own premises to cope with the new rated voltages and introduce protective earthing system. Small light consumers at 127V single phase need only to change bulbs, fluorescent tubes, radio etc. The kWh meter and necessary modification up to the meter shall be included within the project. Usually refrigerators, TV, musical instruments, and electric iron are operating at 220 phase to phase and 220V single phase operation shall have no problem. For electrical equipment that have dual modes of operation i. e., 110/220 V, care should be taken in switching the appropriate button.

b) Small commercial consumers are same as (a) above but in addition to the above shall be required to change small 230/127V equipment to 400/230V.

c) Small industrial consumers are affected very little if at all as they are mostly employing 400/230V systems.

d) To avoid voltage drops or keep them at acceptable levels in customer premises, the transformers shall be positioned within less than 500 meters apart.

Environmental screening

The Task Team in consultation with the project team of EEA, conducted the following socio-economic and environmental impact screening exercise as summarised in a tubular form below.

Table 6-2 Ratings of Environmental and Social Impacts, Component I

Socio economic and environmental impacts	Rating of impacts		
	High	Moderate	Low
Excavation of underground cables on urban traffic		✔	
Denial of or restrictive access to economic resources, land, fodder, property, buildings, roadside trees, etc		✔	
Private land, garden requirement for transformers			✔
Slow backfilling of excavated surface	✔		
Dust and dirt		✔	
Damage to other underground systems			✔
Power cuts to sensitive customers		✔	
Erection of overhead ABC cables, open wire overhead			✔
Socio-economic impact of voltage conversion to customers		✔	

However, the screening exercise shall be effected for each of the project sub components before each project activity commences in collaboration with the concerned stakeholders. Mitigation measures and corresponding environmental management and monitoring plan shall be formulated in later chapters for those evaluated as high and moderate impacts only. For those categorised as having low impacts, effort shall be done to totally avoid or reduce to acceptable levels and thus can be prudently dropped from further considerations in this report.

B. Rural Electrification Component

The major environmental impacts for the rural electrification projects include:

Environmental

- Damages to agricultural products
- The cutting of trees and branches
- Securing an optimum right of way
- Some access roads may pass through farmlands
- Some of the project areas may be mined

Poverty related drawbacks during electrification

- Inability of poor households to pay for connection, in-house wiring and electrical appliances. This is an important socio-economic survey finding which requires project actions

Post-electrification Management Related problems

- EEA will have difficulties in the management of electricity services
  - Meter reading,
  - Bill preparation and distribution
  - Tariff collection
  - Entertaining new connection applications
  - Repair and maintenance of the system

Possible Environmental Damages

The referred World Bank and national Safeguard Guidelines call for environmental screening of each proposed project component to determine the appropriate mitigation measures of negative impacts. The major environmental impact for the rural electrification projects is the possibility of damages to agricultural products during the construction work. Such damages can be significantly reduced or totally eliminated if erection of poles is programmed during the dry season when there is no growing or matured crop. This has been the norm in the already electrified villages. As the village communities shall be fully involved in the electrification process to reduce overhead costs for erection, which is considered part of their contribution, any unavoidable damage is acceptable to the village as a whole. In the first place, an optimum Right of Way (ROW) that minimises such damages shall be selected for the connection of the overhead lines. Routing of the lines will be done in close co-operation with the local authorities and compensation will be paid to affected landowners, if any, in accordance with the RPF. The pole erection routes shall as much as possible be close to existing roads for easy access; note that nearly all highland villages have dry weather road

access. Erection is also mainly made with the minimum use of heavy vehicles. There is no problem if some access roads or pole routes pass through farmlands provided it is done during the dry season, according to the interviewed farmers. The work team shall avoid routing the pole sites through above-surface heritage sites and solve any incidental outcomes on site by inviting the concerned caretakers.

The cutting of trees and branches is rarely done if at all in this project. Note that Eritrea is already suffering from deforestation and its impacts; forest cover is below 2%. Trees are highly valued and their cutting without permission is illegal for whatever reason, according to the Ministry of Agriculture Regulations. There is massive ongoing afforestation program on grazing lands and along roadsides. It is quite common to see newly planted trees traversing farmlands along the roadsides and there is no popular complaint at all. In fact the villagers co-operate to give water to the young trees during the dry season. In the rural project areas the average height of natural trees above ground is below four meters and the conductors are positioned well above 5-6 meters. Plantations like eucalyptus can grow much higher and the route for pole erection has to be diverted away from them.

Project areas that may have land mines

The War of Independence (1961-1991), combined with the recent border conflict with Ethiopia (998-2000), has left a legacy of landmines and unexploded ordinance (UXO) across the country. After independence, the GoE started mine clearance through its National Demining Agency within the Ministry of Defence with the assistance of the USAID and as many as 500,000 landmines were removed between 1993 and 1998, clearing much of the country. Some reports indicate that more than 100,000 mines have been laid down during the recent conflict with Ethiopia[5]. These are concentrated largely between the trenches along the confrontation lines near the border. Some places within the 25 km Transitional Security Zone (TSZ) which were temporarily occupied by the invading Ethiopian forces could still be contaminated. Villages located on both sides of the road between Senafe and the border town at Serha near Zalenbesa, Tsorona and its environs, Shambuko and Tekombia areas are among the suspected areas.

Most of the rural electrification areas are safe from landmines. The Eritrean Mine Action Program is exerting great effort in clearing landmines from the suspected areas. With the co-operation of the Mine Action Program and the project team the risk of landmines can be neutralised.

Poverty related

Poverty of the rural poor is the most pressing national problem in the Eritrean context. Its eradication requires intervention from the government and development partners as envisaged by the Millennium Development Goals. The provision of modern energy is essential but not sufficient condition for poverty eradication or reduction. Integrated rural development programs that could be facilitated by e. g., electrification, is the way forward. Believing that rural electrification will help stimulate rural development, the government together with its development partners is covering part of the expensive ongoing rural electrification scheme and that anticipated in this project. To strengthen the sense of ownership and belongingness, the benefiting communities are already covering the rest and will do so in this project. Average income of the village communities may still be low but their community members

[5] Landmine Monitor Report 2000.

residing in the urban areas or in the Diaspora are playing constructive role in filling the balance especially for the common expenses. Moreover, payment in instalments (essentially meaning from two harvest seasons) is also allowed. Micro-financiers could avail credits if the applicants could justify income-generating activity using the electricity to repay the loans. To help the exceptionally poor, traditional savings and helping mechanisms like the "Equb" may be beneficial and has to be promoted in this project.

Management related
It is observed that EEA has faced shortage of manpower in administering electricity services in the already electrified semi-urban centres and villages (refer to Appendix C). This includes inspection of in house wiring, meter reading that could be private or shared, bill collection and distribution, tariff collection, new connections, attending complaints and grievances, etc. The only way out is to delegate this responsibility to electricity co-operatives and/or EEA service agents and this approach shall be dealt with in greater detail in Chapter 9 on Management and Monitoring Plan.

Screening exercise of possible negative environmental and socio-economic impacts for the Rural Electrification Component is also summarised below.

Table 6-3 Ratings of Environmental and Social Impacts, Component II

Socio economic and environmental impacts	Relative Ratings		
	High	Moderate	Low
Damages to agricultural products during construction			✔
The cutting of trees and branches			✔
Securing an optimum right of way			✔
Denial of or restrictive access to economic resources, land, fodder, property, buildings, fruit trees, etc			✔
Pole erection passing through farm lands	✔		
Some areas may be mined		✔	
Potential damage to cultural heritage sites			✔
Poverty related	✔		
Management related	✔		

As for the Component I, the mitigation measures as well as the ESMMP in Component II will focus on those impacts that have been rated high and moderate and only a passing remark for the low impacts will be given in the later chapters. Note that when project execution starts, each village to be electrified has to be considered for separate environmental and social impact analyses and screening following the general format given in Appendix F.

6.2 Positive Impacts of Rural Electrification

The absence of reliable energy supply in the form of electricity and strong focus on welfare projects have numerous negative impacts on rural income generating activities as exemplified by the following case study. In the Ala Plain, according to the survey conducted by Semereab and Zemenfes (2001), for instance, the increasing cost of diesel and expenses for repair and maintenance which have to be done either in Dekemhare or Asmara has a very disruptive effect. The average fuel consumption per week and per irrigation event was found to be 94.8

litres and 119.5 litres, respectively, per farmer. Thus annual fuel consumption is calculated to be 520 litres per hectare. This amounts to the annual energy cost of 1458 Nakfa per hectare. With a steady decline of the water table at an average rate of 100 cm per year, the cost of pumping water is also rising. As the depth of wells increase, many farmers are forced to use two or more water pumps that operate in a relay system. The average number of motor pumps per farmer and per hectare are respectively-2.7 and 0.4. In the final analysis as revealed in the study the share of energy cost in the total production cost is estimated to be 17.6%. In another study of four small irrigation farms around Agordat whose cultivated lands are respectively, 1.5 ha, 3 ha, 7 ha and 10 ha, the share of energy costs as percent of their total input cost were respectively, 53.9%, 48.9%, 38.8% and 44.9% (yielding an average of 46.6% (Elias, 2000). This large share of energy cost coupled with a rising fuel price has become cumbersome and narrowed down the profit margins of almost all farmers, decreased the frequency of irrigation and negatively affected loan repayment.

The average energy used per hectare in Ala is about 18 GJ, and compares very poorly with similar activities elsewhere. In Pakistan, the average energy used stands at about 35 GJ per hectare while in the USA it is about 70 GJ. It has been found that there is a positive correlation between the amount of energy used and productivity per unit land. Thus yield per hectare in the USA are twice as large as that of Pakistan. Clearly, increased energy use by Ala farmers in the form of increased frequency of irrigation would improve productivity, but under the prevailing shortage of water conditions, such increase is unlikely to occur.

Moreover, as the depth of wells increases, the wear and tear of motor pumps increases due to the stress induced by increased temperature. This causes frequent damage to motor pumps and increases the maintenance costs. It is often recommended that farmers should set aside 10% of the price of a motor pump every year for purposes of maintenance. However, due to the rising production costs one of which is fuel cost, farmers are finding it difficult to stick to this norm. When such damage occurs, motor pumps are taken to Asmara or Dekemhare and may take weeks or even months to repair. This is for dealers which keep enough spare parts, but for others, the repair might take even years. When such a problem occurs, those who could not afford to buy new motor pumps are forced either to abandon their farms or lease them to persons with motor pumps on 50%-50% basis of income sharing.

The motor pumps used by the Ala farmers exhibit low efficiency and frequent breakdowns due to improper maintenance. When spare parts are not available, local workshops manufacture "modifics" that only fit pumps poorly. Coupled with improper handling and uncertainties, and worn out parts - pistons, liners, bearings, etc., the efficiency of such motor pumps is likely to be quite low. Studies done elsewhere (e. g., India) show that for motor pumps of 50% efficiency during manufacturing, it can go down to as low as 15% in the field and increase fuel consumption by over 3 times. Thus, a diesel pump of 3.75 kW designed at 1 litre/hr might end up swallowing 3 litres/hr.

Of the interviewed Ala farmers, 95.2%% enthusiastically supported electrification. All of those who support electrification expressed their willingness to share expenses with the government on loan basis (62.5%) or direct cash payments (30%) or both 7.5%. The advantages they envisage are:

- Reduced energy expenses;
- Improved motor pump efficiency as submersible electric pumps can be easily used inside deep wells;

- Extension of electricity to the area could trigger the establishment of repair workshops and garages in the locality thereby improving the maintenance service and reduce expenses; and
- Open new opportunities for the diversification of sources of income through the development of other sideline activities.

The cost of electricity produced by the gensets is at least twice as expensive as grid electricity. This is mainly due to high cost of transporting diesel to remote areas as well as high maintenance costs and small capacity of generators. Despite such high costs, users tend to give high value to the power generated by gensets as it is flexible enough to meet the energy needs for domestic and income generating activities. Clearly, gensets are uneconomical for large-scale rural industrialisation, and it can not be a substitute for grid extension. However, as experience indicates, gensets play an important pre-electrification role in demonstrating the advantages of modern energy services in remote localities, and they pave the way for the extension of grid electricity to rural areas. It is not uncommon to see gensets to be removed and sold elsewhere in unelectrified area when the grid is extended in their initial installation area, continuing their pre-electrification role.

What is of interest here is that when utilities like EEA refrain from supplying rural areas with electricity due to low initial demand, rural entrepreneurs short-circuit to electricity supply by using gensets. What the utilities have failed to realise, as the Eritrean data shows, is that electricity or any other modern energy tends to create its own demand once the service becomes available, due to its attraction and ability to support diverse income generating activities.

It is obvious that rural electrification will reduce the burden of women due to the emergence of electricity driven facilities, problems associated with gensets or diesel pumps and energy expenditures as the following argument reveals. The sole power utility, EEA, supplies grid electricity at the same tariff to both urban and rural households, and at a flat rate to MSMEs, irrespective of the amount used. Since March 1st, 2003, EEA charges 1.55 Nakfa per kWh for households and 1.95 Nakfa/kWh for general public and commercials, Nakfa 1.56 for small scale industrial uses; the tariff for big industrial uses is 1.00 Nakfa/kWh for the first 100,000 kWh/per month and 0.74 Nakfa/kWh for each additional consumption. The electricity tariff of the EEA clearly favours the big industrial consumers and the intention is to assist them in becoming competitive in the international market. Compared with most African countries, the tariffs here lie somewhere midway. It has to be acknowledged that the tariffs are still quite high considering the poor economy of the country but it has to be recognised also that one form of energy, expensive oil products, is being converted to produce electricity. The government has no capacity or the willingness to subsidise it. However, there is a minor cross-subsidy between the cheaper large- scale generation of the integrated systems and the more expensive small-scale generation in the self-contained systems.

The average price for electricity generated by remote municipal (unsubsidised) and privately owned gensets is at least 4.00 Nakfa/kWh. These figures show that electricity from private suppliers is 2 to 3 times more expensive than electricity supplied by EEA. This price difference is mainly due to the small capacity generators used by such suppliers, whose specific fuel consumption is much higher. It has been found out from the EEA systems that the cost of electricity generation ranged on the average from 0.55 Nakfa/kWh for systems using generators $\geq$ 2 MW to as high as 2.50 Nakfa/kWh for systems that used generators $\leq$

0.5 MW during the first half of 2003. This justifies shift to EEA electricity whenever available in rural areas.

7. MITIGATION MEASURES

In the previous chapter, potential environmental impacts of the scheme were identified. This chapter investigates options for mitigating or eliminating these impacts, either by changes to the scheme design or by controls on working practices during the construction and operation phases. In the following chapter recommendations are made as to which options should be implemented and which parties should be responsible for their implementation.

7.1 Mitigation measures in Asmara Power Distribution component

This component is a multi-million project that requires careful division of responsibilities among the implementers, namely, EEA, external engineering company, local electrical contractors and customers. Reducing or mitigating the negative impacts requires systematic co-ordination among the stakeholders. At the stakeholders' workshop conducted on August 1st, 2003, the following mitigation measures were presented for discussion at the Group Sessions:

- The forthcoming detailed engineering design shall make apparent the areas that require mitigation measures
- Urgency required in laying underground cables and refilling of the pathways
- Use existing maps of buried water supply and sewerage, telecom cables required and produce GIS in collaboration with the Department of Infrastructure
- Follow Department of Infrastructure Regulations to avoid damages
- Whenever electric and telecom cables meet, use perpendicular crossings with enhanced insulation
- Covert the radial to double-fed loop structure to avoid extended power cuts to all customers
- Use mobile diesel generators to supply critical customers and/or encourage them to have standby generators
- Other engineering design required e. g. to change the transformers (indoor or mast-mounted)
- Arrange different construction crews for MV and LV
- Prepare the customers for the voltage conversion

The participants were asked to comment on the appropriateness and completeness of these mitigation measures. The above were favourably accepted but recommended to include the need to make an assessment of financial implications to possible damages on other underground utility networks/services such as water supply network, telecom cables network etc. Actually EEA is going to take full responsibility to cover the cost for mending the damages if they happen even if it may mean allotting additional budget to the already committed for the project. This is in line with the relevant Regulation of the Ministry of Energy and Mines as stated in Section 2.4.5.

Moreover, the participants were specifically asked to share their observations on the positive and negative lessons that we can learn from the ongoing Asmara Water Distribution Project

and the Massawa Power rehabilitation project. The following frank opinions were the consensus on the problems related to the Asmara Water Project:

- Poor planning and approach, poor relations with stakeholders;
- Disorganised time (season) and implementation program;
- Poor information network with relevant institutions;
- Environmental problems such as debris & wreckage remnants;
- Poor awareness and safety measures;
- Frequent blockage of roads, traffic jams;

From the Massawa project negative lessons learned include i) delay of work, ii) delay in reinstating roads and side walk infrastructures, and iii) poor awareness measures.

Positive lessons from the Asmara Water Project include: - supply & service improvement; minimisation of wastage; technical skills and efficiency developed; and local experience on project management enhanced. Similarly, the positive observations from the Massawa project include: -

- Local capacity both on technical and managerial skills developed
- Experience on project management enhanced;
- Sustainable and standardised electricity service established;
- Well organised with regard to planning

While appreciating the Ministry and EEA initiative to arrange such a stakeholders' workshop, the participants had the consensus view that the negative impacts observed in the other referred projects should not be repeated in the Asmara Power Distribution Project and have recommended additional measures to enhance positive impacts. It is expected that the detailed engineering plan discussed below will incorporate most of the technical matters of the mitigation measures. To co-ordinate the inter-sectoral tasks and follow-up the implementation plan the stakeholders' meeting proposed the establishment of a Project Management Team which is also in line with the mutual agreement between the Ministry of Energy and Mines and the Bank.

Detailed Engineering Design

Detailed engineering design is yet to be produced by an experienced foreign engineering company. From the terms of reference for this task, the relevant sections to this chapter are extracted below:

Objectives

Consultant services from qualified power system designers are required to plan, design, specify, and supervise the construction of Asmara Distribution system rehabilitation. The completed system shall be capable of supplying for the future (15 years for cables, 8 years for transformers) of demand in a reliable and least cost manner.

Operational strengthening of EEA is also required, through training leading to the use of current standards in planning, designing, construction and application of modern equipment and operations practices.

Scope of the services
The consultant shall provide all professional and technical services and other related support in accordance with internationally recognised practices for consulting services. Specifically the consultant shall work with EEA to provide detailed design, construction supervision and training for what is necessary to achieve the objectives. The work must be done in Eritrea together with a team of Eritrean engineers.

Among the design and engineering tasks given to this consultant is the preparation of an implementation plan with emphasis on: -

- Construction methods and schedules.
- Temporary supply arrangements during transition. Mobile transformers and generators may be required to minimise outages.
- Disposal of salvaged material (wire, old transformers, poles, etc.) in an environmentally friendly manner.
- Coordination with other utilities (water, telecommunications) to determine mutual benefits, before and during construction.

Moreover, the consultant will have the duty of supervising the work of the contractor, on behalf of EEA, whose details shall be presented in Chapter 9.

Speed in excavation and refilling of underground cable pathways

It is a fact that most of the medium sized buried water pipelines along the pavements and inside the secondary roads of Asmara City have not been covered properly for over a year now in the Asmara Water Distribution project. Similarly a delay is observed in the Massawa Distribution Rehabilitation project. This manifests lack of co-ordination and monitoring. Only refilling by the excavated soil has taken place and levelling as well as surfacing it with ceramic tiles to the pavements or asphalting the roads is yet to be conducted. This has created problems to urban traffic and has become an eye sore in the respective cities. Thus, it is essential to have a speedy excavation and refilling and surfacing of the underground cabling in the Asmara Power Distribution Project. It is anticipated that this work shall be subcontracted to local construction companies.

Synergy between water, telecom and electricity authorities

In the process of establishing a land and service provider's database for Greater Asmara, the inadequacy of existing spatial and non-spatial information systems was found to be a major constraint for data exchange between service provider institutions and the Department of Infrastructure. The absence of commonly agreed standards aiming at defining contents, formats and poor quality of the information affects negatively the executions of development projects. The problem is now addressed by the Zoba Maekel Administration region. A plan of action to initiate a process leading to a standardised database structure, integrated for the Maekel Region is to be developed. To help achieve this goal, the August 1st 2003 stakeholders workshop recommended the following measures.

- Consultation & participation of stakeholders during planning & implementation stages of the project is essential.

- Development of information network and manipulation of functional softwares and GIS, are effective in facilitating the project task.

- Establish coordination committee among sectors most relevant to the project.

Mobile diesel generators and transformers for critical customers

Critical customers are those customers where prolonged power cuts (during rehabilitation and voltage conversion) may seriously affect peoples' health, causes property damage and hampers public services. At the stakeholders' workshop, there was a general consensus that the critical customers should have had their own standby generators in the first place. This could help reduce project costs by avoiding the need for mobile generators and transformers. Nevertheless, the project has the provision to utilise mobile diesel generators and transformers for temporary supply arrangement whose implementation plan is expected to be formulated by the consultant.

Department of Infrastructure Regulations

It is clear from section 2.4 that the Task Team were not able to get for the ESA report, the necessary detailed information that is digitised on existing utility lines, water supply, sewer, telephone and electricity from the Zoba Maekel Infrastructure Department or other concerned departments. Indeed, the concerned participants have also acknowledged this during the stakeholders' workshop of August 1st, 2003. The Zoba Maekel Infrastructure Department, in its written communication with the Department of Energy, congratulated the successful workshop while expressing a disappointment that no such reliable, informative and professionally organised data systems exists for the city of Asmara. It further expressed its concern that the absence of such data will have due effects on the financial cost of the power distribution project. It will be evident that the contractor(s) who will be executing the installation of the project will do so without the knowledge of the exact position and location, henceforth incurring potential damage on the existing lines. The letter was also informative in sense that a lot of effort is being exerted in collaboration with the relevant institutions to produce such systematic digitised data base so that future work will be facilitated with a simple click and/or double click on the computer to generate any information that one may require. With this intention it pledged for a support to the coordination effort being made between utility service providers in Asmara. As part of this endeavour, a request has been presented for consideration and inclusion of a GIS (Geographical Information System) of underground utility geo spatial cabling, as additional work to the Asmara Power Distribution component.

Conversion from the radial to double-fed loop distribution structure

The engineering consultant shall review the feasibility report prepared by IVO/Electrowatt and this report as well as design the layout of the required engineering work for the contractors concerning the change over from the radial to the double-fed loop distribution structure.

7.2 Mitigation measures of negative impacts in rural areas

The following table summarises the possible negative impacts and proposed mitigation measures for the rural electrification component, which were presented at the referred stakeholders' workshop for discussion.

Table 7-1 Negative impacts and corresponding mitigation measures

Negative Impacts	**Mitigation Measure**
Damages to agricultural products	Erection during the dry season
Vegetation damage, habitat loss and invasion by exotic species along right of way, access roads and around substation	Utilise appropriate cleaning techniques Maintain native groundcover beneath lines Replant disturbed sites Manage right of ways to maximum wild life benefits
Habitat fragmentation or distribution	Select right of ways to avoid important natural areas Maintain native vegetation beneath lines
Run-off and sediment	Avoid water bodies, flood plains and wetlands Design drainage ditches to avoid affecting nearby lands
The cutting of trees and branches	If unavoidable minimise
Securing an optimum right of way	Involve local administration and people
access roads may pass through farmlands	Limit the use of heavy vehicles and pay compensation for damages
Some areas may be mined	Ensure mine clearance beforehand
Poverty related	Expand micro credits and income generating activities
Management related	Introduce energy service companies, EEA agents and/or Electricity Co-ops in the villages

In the first place, an optimum Right of Way (ROW) shall be selected for the connection of the overhead lines. Routing of the lines will be done in close co-operation with the local authorities and compensation will be paid to affected landowners, if any. Routes shall as much as possible be close enough to existing roads for easy access. Most of the erection will be programmed during the dry season (nine months in most places), when there is no growing or matured crop. Erection is also mainly made without use of heavy vehicles and localities are to be involved in the erection work and the work team shall solve problems on site.

Issues for Discussions & Recommendations

Group 2 of the stakeholders' workshop that deliberated on the above rural electrification impact mitigation measures was specifically asked to respond to the following issues and give recommendations:

1. Are the negative impacts exhaustively identified? If not what can be added?

2. What can we learn from positive and/or negative performances of the past and ongoing rural electrification projects?

3. Are the mitigation measures proposed exhaustive, sound and practicable?

4. What comments do you have on the cost sharing policy between the government and its development partners on the one hand and the benefiting communities on the other?

5. There is no doubt that the community contribution enhances the feeling of ownership and responsibility, which is beneficial in sustaining the network. What implementation problems and or good practices have you noticed from your side?

6. As per the cost sharing Directives of the Ministry stated above, only villages that have taken initiatives to raise money to cover their share shall have the benefit to be connected from the project target areas. Villages/towns from other regions of the country can also be electrified provided the same initiative is undertaken. Payment in two instalments (effectively two harvest seasons) is permitted. Your comments on this approach are helpful.

7. The mitigation of adverse socio-economic and environmental impacts of the project requires appropriate *management and monitoring plans*. What can you add to enrich the plan presented?

The responses can be summarised as below:

On identification of negative impacts;

- Intensive safety measures through media coverage are necessary to enhance the awareness of the people on the potential safety hazards of rural electrification. The discussion group was informed by EEA's Head of Distribution that EEA takes care of the safety measures upto the kWh meter and does not inspect the safety of in-house installations. Eventhough, no accident has been reported caused by faulty installations in the recently electrified areas, the group expressed concern that the work has to be done by certified practitioner in small scale electrical installations. They recommended that each village has to have a trained electrician. This electrician could also be involved in administering the electricity services at the village.

- Sensitive areas such as monasteries, symmetries, should be identified before any action is taken, especially during extension of the distribution lines lines. Effort should be done to recover discovered belowground cultural heritages during the construction phase in collaboration with the National Museum.

- Introduction of preliminary villages' master plan is essential technically & financially for EEA, and environmentally for the villages. The absence or late supply of such plans has lead to frequent revisions of cost estimates by EEA in past electrification projects.
- The issue of erosion during and after the electrification processes such as lining of roads and plantation of electric poles should be addressed. This is relatively a minor problem as

the pole bases in the ground affect very small areas. Care should be taken to avoid destruction of landscapes having tourist attractions.

On positive impacts

- Implementation of electrification program is underway according to the plan
- The horizon of consciousness of people is enhanced, due to communication accessories such as radio, TV (local & Satellite dishes) as a result of electrification
- Health concerns such as eye and lung diseases due to smoke are reduced; the simultaneous dissemination program of improved biomass stoves has enhanced this claim
- Small-scale commercial and service enterprises have started to appear and grow in the post electrification era.
- Students particularly at a secondary level extended their study time to equalise their counterparts in the cities, i.e. rural students competitiveness is increased.
- Time for family issues are prolonged i.e. families spent longer time with their children.
- People's (villagers) moral is boosted and urban people attendance is increased.
- Women's drudgery and domestic chores has decreased through the use of electric mills, electric water pumps, domestic lighting and power, etc,

On mitigation measures proposed

In addition to the proposed above, careful measures should be taken not to alienate the economically nonviable villages & poor households. The group as well as the Task Team have the consensus view that most of the negative impacts on the natural environmental stated in Chapters 6 & 7 are not serious and with proper planning of the mitigation measures can be deemed irrelevant.

On cost sharing

The existing cost sharing policy of the Ministry of Energy and Mines is meaningful and applicable.

On community contribution and ownership

It is advisable that the management of electricity services in the rural areas be largely the responsibility of the villages/towns by involving trained technicians and or energy service companies. However, EEA should take the responsibility for repair and maintenance of high medium and low voltage distribution lines. The cost of repair for damages inflicted by a third party should be the responsibility of that third party.

On schedule of rural electrification

First come first serve, for villages that can afford the required payment, is the most productive style of electrification. On the one hand it creates healthy competition among villages and on the other it keeps the continuity of the process of electrification as a whole. In doing so, EEA has to select the optimum right of way for the potentially electrifiable villages in cases where these have been bypassed in electrifying a further village or semi-urban centre along the route.

On management and monitoring

With regard to management of reading meters, distribution & collection of bills and in-house installations & maintenance, the EEA or the Department of Energy have to train technicians

to serve as liaison or commission agents agent for EEA. Besides the technician will be responsible for in-house installations and maintenance activities. Monitoring the activities of the technician will be the task of EEA. This will pave the way for the establishments of rural energy service companies who will have a wider scope in energy business including distribution of oil products, renewable energy technologies etc.

8. ANALYSES OF ALTERNATIVES

8.1 Asmara Power Distribution Component

There is no engineering related alternative to the upgrading needs of the Asmara Power Distribution (Rehabilitation and Voltage Conversion) project component apart from the choices of voltage levels, transformer sizes and conductor types and sizes. IVO/Electrowatt, who did the feasibility study and provided the technical justification (see Section 4.1), acknowledged in their report that no optimisation of the to-be-selected Medium Voltage level has been included in the study scope of works. They accepted from the outset that the choice of 15 kV medium voltage distribution system for urban sizes like Asmara for loads amounting upto 100 MW is reasonable. The selected 15 kV rated voltage is still being used in various areas in Europe having similar power load densities and to-be-awaited peaks as assumed in Asmara for the coming 30 years. EEA has already been implementing the 15 kV extensions to the suburb and peripheral areas of Greater Asmara. In Massawa and Ghindae, where more heavier industries are expected to be located, power distribution upgrading and rehabilitation is proceeding also at 15 kV medium voltage.

The IVO/Electrowatt recommendations for associated replacements of equipment and materials including 15/0.4 kV transformers, HV/LV switch gears, underground/overhead cables and conductors for medium/low voltage distribution shall be applied. As detailed engineering design is yet to be undertaken by experienced external consultants, sound alternative approaches may be entertained within reasonable budget limits.

8.2 Rural Electrification Component

Rural Electrification (RE) has long been seen as a factor of socio-economic development. It is believed that it is a necessary catalyst to improved rural productivity and quality of life. Although the cost of electrification is very high and not generally cost effective from utilities point of view, the values derived from services provided by electricity in terms of better opportunities for education, health, entertainment, comfort, convenience and enhanced productivity make the balance, justifying support from government and donors.

The objective of rural electrification is to provide electricity to rural villages surrounding towns with existing generating stations and by reinforcing associated transmission lines, substations and distribution networks. The Eritrea Electric Authority has been implementing 15 kV interconnections between major generation centres and small generation centres like Senafe, Segeneyti, Adi Quala, Elabered, Hagaz and recently Debarwa, Adi Tekelezan, Aligider, Alebu etc. The extension to these small towns has enhanced rural electrification by enabling villages in between to get electricity supply slowly and steadily.

Rural Electrification project in Phase 1, initiated in 1999 which included the towns of Debarwa, Adi Tekelezan and Tesseney-Alighider-Alebu and surrounding villages are now completed. The villages and towns electrified are 24 (see Chapter 3). Rural Electrification project in Phase 2 which includes Himbirti, Mekerka and Mendefera areas is being implemented and shall electrify 41 villages. Both Phases 1 & 2 are financed by the state of Eritrea, the Community and *the* Government of Sweden. Three phase 15-kV/0.4 voltage

levels have been used for the supply of electricity to all near urban hitherto electrified rural areas. Three-phase is likely the best choice for these villages as electrification will lead to economic growth and the nearby villages could become bedroom communities for the load centre Asmara and the other urban areas resulting in high load growth in the future. For villages located further away from the urban centres, other options of rural electrification discussed below could be considered for economic effectiveness as the use of electricity for domestic purposes is likely to dominate.

Future Electrification Project, Phase 3

The Eritrea Electric Authority assisted by the World Bank has prepared two Rural Electrification Projects as follows: -

a) Keren and Barentu Areas comprising of 26 villages and small towns (North Western and South Western Eritrea)
b) Dekemhare and Adi Keih Areas comprising of 68 villages and small towns (South Eastern).

The project intends to introduce *new Rural Electrification concept* such as (a) Phase to Phase, (b) Phase to Neutral and (c) Single-Phase-Earth-Return systems. The adoption of these systems depends on the soil situation of the area to be electrified and as such the soil condition of the areas have to be investigated by outside experts with experience in the field. Towards this end, EEA has selected AFRICON, the Professional Services in Development consultant from South Africa.

The Single-Phase-Earth-Return, Phase to Neutral and Phase to Phase systems i. e. c, b, and a above, are most economic in the order arranged. Hence even if the single-phase-earth-return is not found feasible, introduction of (b) and (a) is highly recommended, as they are much cheaper than the three-phase system EEA has been adopting in the past and current programs. In system (a) two phase conductors are used and this means a saving of 33% and (b) one phase conductor and one neutral conductor are used implying a saving of about 50% and if (c) is feasible a saving of about 67% can be achieved.

For remoter villages and small towns (far from grid) that are not included in this project, a grounded single-phase, single wire earth return system may be worth considering in the future. This shall be realised if Eritrea has good earth return grounding geology, which shall be studied in the near future. If the study confirms the soil conditions are suitable, EEA has decided to introduce 33 kV system as grounded-wye, instead of 15 kV delta for rural areas. The selection of 33 kV shall enable rural electrification systems to extend up to 100-120 km, depending on the load. The use of these higher voltages shall reduce the need for transmission. The higher voltage would reduce the number of feeders as more power can be transmitted with lower current. Line construction cost are reduced as fewer poles and smaller conductor sizes can be used. There would be need for fewer breakers, lower current rating equipment and thus lower cost MV apparatus. The higher voltage equipment cost premium, would be at minimal, as most of the apparatus costs are similar up to 33 kV. The higher voltage lines will enable longer distance feeders with fewer higher voltage substations, especially given the anticipated light rural loading. The longer MV feeder would also mean fewer high cost transmission lines and apparatus (substations), thus reducing the cents/kW average cost of transmitted power. The most significant benefit of higher operating voltage is

lower power losses, which in turn reduces costs through reduced need for installed generation capacity.

One of the key improvements that can save overall apparatus costs is the benefit of a grounded -wye versus delta systems for MV distribution. Many utilities (especially in North America) are converting from delta to grounded - wye MV systems. The advantages are numerous, as this allows lower cost and more effective protection system, lower rating Base Insulation Level (BIL) components and more flexibility of customer transformer connections. The higher MV standard (15 kV versus a higher say 33 kV) and the potential for a grounded system should be evaluated by the consultant. Since EEA is adding a significant amount of power apparatus, the long- term benefits may be worth considering: -

Major benefits of the delta system is that feeder loading is balanced and the low voltage faults are of less consequence to the MV system; both of these are easily managed through design in a grounded system. Mixture of 15 kV delta and 33 kV grounded - wye systems can be looped and operated momentarily given the correct phasing. This can be achieved through the appropriate use of zigzag transformers. The major drawback of changing to a grounded system is that the existing connection of 15 kV delta would increase inventory requirements for spare parts, more design standards etc, until conversion to the new standard.

EEA should conduct a study to determine if a single-phase earth grounding system is suitable for Eritrea geology. The sparsely populated and low load characteristics of rural areas are ideal for single phase grounded system. Single wire, with earth return can save substantial costs especially in low load and low growth areas. Again the existing 15 kV delta system is not suitable for this. However, a 33 kV grounded wye system could use some of the same single-phase components used in the existing standard 15 kV delta.

IEC publication 38 prescribes three families of medium voltage levels for the public power systems: - 10-13 kV, 20-25 kV and 33-35 kV. The medium voltage (MV) will preferably be chosen among these ranges to supply rural areas. When voltages are chosen outside these ranges, the equivalent equipment that has to be installed is more expensive.

9. Environmental Management and Monitoring Plan

In Chapters 6 the positive and negative impacts of the proposed scheme were identified and assessed in relation to their magnitude, and potential mitigation measures were examined in Chapter 7. In order to assess the effectiveness of these measures, or to identify further corrective action and to detect any impacts that may not have been identified during the ESA process, it is essential that an Environmental and Social Management and Monitoring Plan (ESMMP) for the project be implemented. This is also one of the World Bank/IFC requirements. This ESMMP recommends mitigation measures that should be implemented in order to eliminate or reduce significant adverse environmental or socio-economic impacts to acceptable levels. The ESMMP measures are discussed with reference to their costs, whether they are to be implemented during the construction and/or operational phases, and the agencies responsible for their implementation. This chapter also outlines areas where institutional strengthening, technical assistance or training, or additional human or financial resources may be required. Finally, it provides a framework for monitoring schedule, reporting and review, in order that stakeholders are kept appraised of the actual impacts of the project, and modifications can be made to the ESMMP as necessary. To help us elucidate the management and monitoring plans for this project, it is reasonable to digress into the recent performance of EEA.

9.1 Background and lessons learned concerning performance of EEA in recent years

In Eritrea, the public utility, Eritrea Electric Authority, now operates the centralised electricity generation system involving an installed capacity of around 150 MW (including the 84 MW new power plant at Hirgigo near Massawa), and up to 1010 kms of transmission and distribution lines (≤ 132 kV). Around 90% of this capacity is integrated (supplies Asmara, Massawa, Keren, Mendefera, Dekemhare and other 9 smaller towns) and the rest is self-contained system that supplies the six towns of Assab, Adikeyieh-Senafe, Agordat, Barentu and Teseney. There are 4 other remoter small towns, namely Nakfa, Afabet, Tio and Tsorona, served by small genset systems owned by the respective municipalities/local governments, which in effect is decentralised. Still there are other semi/urban centres being served by private gensets.

As shown from its EEA 2002 report, its generating plants produced 249 GWh. The average electricity generation was 4 kWh/litre of oil products, from all the systems. The sold electricity, including EEA own consumption, was 206 GWh implying a loss of 17%, which is mostly technical, theft being non-existent. In 2002 there were over 103,000 customers. The number of employees was 710 of which 573 are male and 137 female; this implies a customer employee ratio of 141:1. It doubled the power generation capacity of 1991 by end of 1995 and this in turn was more than doubled after the commissioning of Hirgigo Power Expansion and Transmission Project. It is also implementing power rehabilitation for the Massawa region and voltage conversion for some parts of greater Asmara. Thus, EEA has developed the requisite capacity for the management of power projects.

Rural Electrification in Practice:

The EEA performance with respect to rural electrification, as a pioneer for the centralised option, has to be judged from its activity in supplying and managing power to the rural households and institutions. In reality rural electrification is perceived by EEA as uneconomical and thus it shies away from grid expansion to villages by its own initiatives. However, after payment of full costs upfront by the beneficiaries (100% of material + labour +20% overhead), it has been electrifying villages near enough to urban centres. With the intervention of the government and its development partners as part of their social policy, rural electrification is now being intensified. The general approach is that the government covers the cost of the medium voltage distribution lines up to the centre of the village or town and the benefiting communities share the low voltage distribution within their locality and cover individually the connection from the nearest pole to their respective residence and/or enterprises. Ownership of the infrastructure is still that of the EEA as it has to conduct, extension to new customers, repair and maintenance services and upgrading of transformers when loads increase. However, this project intends to involve the rural communities in the management of electricity services through the formation of Electricity Co-operatives or private energy service companies whichever is found more feasible.

The private sector is already playing a lead role in the dissemination of small decentralised energy systems such as gensets, pumpsets, wood and charcoal stoves, baking ovens, electric and gas cookstoves, LPG cylinders and stoves, electric or solar water boilers, photovoltaic systems for lighting, water pumping, refrigeration, communications, etc.

The progress of rural and semi-urban electrification has already been dealt with in Chapter 3 of this report (see Tables 3.4 and 3.5). To elaborate on the present status of the villages and towns to which electricity has been recently extended reference is being made to another study (Semereab and Zemenfes, 2002). This study prepared and administered a questionnaire on the present condition and impact of electrification in two small urban centres (Dibaruwa and Hagaz) and three villages (Azien, Tsada-Kristian, Maéreba) (refer to Appendix C for details).

Each town and village was requested to pay its share for the extension which on the average came to 640 Nakfa (US$ 63.4) per household, but ranged from US$ 40 to 109 depending on village size and shape; the larger and/or the more compact the village the less they pay; for those electrified later during 2002/2003 it averaged 920 Nakfa. The payment rates are based on actual expenses, which EEA prefers to charge. On top of this, each beneficiary should cover connection costs from nearest pole to his residence/enterprise and internal wiring which on the average is around US$ 30. It has been further found out that all of the concerned villages have formed village Development Committees and fund raising for the infrastructure was organised by them.. EEA staff from nearest branch office goes to the villages/towns to distribute and collect bills monthly or bimonthly. Oftentimes the customers themselves go to the nearest EEA branch office to settle their bills as excerpt from Semereab and Zemenfes (2002) given in Appendix C shows.

The centralised system could not satisfy fully the demand for modern energy services effectively. This is indicated by the EEA's very slow response to new applications even in electrified areas. For instance, the findings reveal that applications for connection with new and/or shared meter remain unattended. In addition to this, customers in certain localities

have to travel to settle their monthly bills elsewhere incurring additional travel costs. The absence of EEA's representatives in the villages/towns also means that the complaints or grievances, new applications and other technical services etc. are not promptly executed.

The Eritrean experience, which is limited to 10 years, indicates that both the centralised and the decentralised approaches to modern energy supply systems have their own limitations. At the same time they are complementary. Moreover, its activities seem to have been over-stretched as a result of which its response to the growing demand is very slow, often frustrating potential customers. Thus, *decentralisation of part of its services is imperative for rapid and wider extension of electricity supply.*

The decentralised system, though it exhibits certain shortcomings, shows very encouraging trends. This system is not only satisfying the existing market demands, but is also expanding the market through the provision of technical and promotional services. The Government's initiatives in infrastructural development and other support services is further facilitating and encouraging the penetration of the private sector in the energy business. This is in line with the general approach of the government in sustainable development that is private sector led and widely shared.

The options are decentralisation either by giving more management roles to the relevant local administrations, or engaging private service agents to manage the distribution of bills, revenue collection and compiling demand applications, complaints and even managing new connections for simple systems. This is exactly what is being done in the Insurance sector; there are at least ten service agents who obtain their commissions proportional to the customers they serve, or the turnovers they manage. The electricity service agents could also get their commissions from every kWh sold in the territories they serve. Local administrative organs can also be involved as in the water supply utility where they are largely responsible for the overall operation, management and expansion activities. The central Water Resource Department's responsibility mainly focuses on conducting feasibility studies, water quality monitoring and other research works. The EEA and/or the Government can also sub-contract the laying of the rural electricity infrastructure to certified electrical contractors. Furthermore, once such infrastructure becomes operational, their management may be left to Electricity Co-operatives or other interested bodies. Through such decentralized approach, 1) the quality of the existing service will be greatly improved, 2) new applicants will be connected faster and 3) the service agents could promote new connections to increase their commission and hence more people could be served.

Proposed Institutional Framework for Environmental and Social Management Issues

EEA has already formed an **engineering team** that took the responsibility of developing the project in consultation with the Bank and is also to collaborate with the engineering consultants, contractors and the Department of Energy in executing the construction work. It will also assign construction crew for its part of the work in Component I. Moreover, it will assign a **Forman with two assistants** for each of the four RE project areas.

To co-ordinate the day to day implementation activity of the financial and technical matters, it has decided, as negotiated with the Bank, to establish a **Project Management Unit (PMU)** fully dedicated to the Project. The PMU will utilise specialist staff from other Ministries and the Local Governments as necessary. To this effect understanding has been made to form

technical committees, involving members from the Asmara Department of Infrastructure, Telecommunication Services of Eritrea, Department of Water, Department of Environment[6] etc. during the project execution. The respective committee members have to be authorised by their respective organisations to act and decide on matters related to their organisations that could be affected by the project. This Unit/Team will be supported by the engineering consultant (s) for both the Asmara Power Distribution and Rural Electrification components. Its overall responsibility lies in the coordination, institutional and legal aspects of the management plan for the Asmara Power distribution and Rural Electrification components, undertaking various studies and to come up with practicable recommendations for sector restructuring activities. Its budget will be from the project funds and the requirements are as follows:

Table 9-1 Indicative budget for the Project Management Unit

Budget Item	Monthly salary, USD	4-year total in USD
Project Manager	1000	48,000
Assistant project manager	700	33,600
Driver	350	16,800
Secretary/Admins. Assistant	250	12,000
Duty Travel (Experts PMU staff)		32,000
4WD Vehicle		40,000
Vehicle running cost		12,000
Computer& office accessories		20,000
House rent and Utilities		24,000
Total		**238,400**

Source: GEF & Govt. sponsored wind energy project in Eritrea.

The **Department of Energy** will co-ordinate some of the management and monitoring functions of the rural electrification component pertaining to training and popular participation and monitor the execution of the whole project by assigning one of its experienced staff members as **Project Co-ordinator (PC)** to this task. The Project Co-ordinator has to be well versed with the energy and environment nexus and be preferably the liaison officer between the Departments of Energy and Environment. Moreover, the PC will contribute towards organising popular participation in the project representing the Department of Energy.

For component II, i.e., Rural Electrification, a supporting committee shall be established with members being the:

- The Director of the PMU
- The Project Co-ordinator from the Department of Energy
- The Director of Infrastructure or Head of Economic Department of the respective Zobas
- , and a
- Representative of the Department of Environment

[6] Note that the Department of Environment whose responsibility it is to be the principal agency in the state of Eritrea for management of the environment is critically understaffed and is thus unable to fulfil completely its mandate. As it has delegated one of its staff members for the preparation of this project, it has promised to also delegate a committee member to the PMU to over-see the environmental matters

The Project Manager of the PMU shall chair this committee. Its main task shall be to assist the PMU to supervise and monitor the execution of the project effectively and facilitate the PMU and Contractor on their respective areas for better performance of the project.

Village Administrators (VA's)- are elected by their local communities and are ideally well-respected individuals who command the respect of their communities. Women fill around 30% of the VA posts. The roles of the VAs in this project include but not restricted to;

- Represent their communities on all matters required of them regarding the RE project.
- Register the names of all households in the villages under their influence
- In close consultation with their communities, organise popular participation for financial and labour contributions to the project to ensure the village share of costs are committed and that no village member is left unelectrified because of poverty.
- Act as liaison between the local community the DoE and PMU officials during the construction of the RE regarding all other matters required in this ESMMP including monitoring to ensure designed mitigation measures are respected during construction and during operation of the electricity supply.
- Commit the local community to binding contracts in cases such as preparation of resettlement and compensation plans.
- To ensure they make available for training, trainable members who would acquire the skills necessary to perform their responsibilities.
- Facilitate the work of the EEA Forman and consultant in the design of optimum right of way for the RE infrastructure

To successfully carry out these responsibilities the VA's will be trained as per the training program contained in this ESMMP. The Department of Energy will take the lead responsibility for this training program.

Environmental Actions before and during Construction for Component I

Monitoring of the impacts of the project should commence as soon as construction commences. Environmental and Social Management and Monitoring requirements are discussed below and summarised in Tables 9.4 and 9.5. The following sections outline actions to be carried out before and during the construction phase of the project. The major environmental concern focuses on the excavation and refilling of trenches for the planned 40-km underground cable networks within Asmara City centre as explained in Section 6.1. The environmental actions are broken down into six sub-phases of construction, as follows:

- Preparation of detailed engineering design;
- Mobilization;
- Excavation of trenches for underground cables;
- Refilling and surfacing of cable pathways
- Establishment of double fed loop distribution system *and transformer cabins*
- Socio-economic impact of voltage conversion to customers
- Advanced Information System to prepare customers to voltage conversion

Preparation of the detailed engineering design

Some of the major tasks for the foreign engineering company to be entrusted with the preparation of the detailed design has been presented in Section 7.1. EEA engineers and planners will participate in this task. They are already aware of the recommendations of the

ESA report and that of the stakeholders' workshop. Detailed mitigation measures and implementation plan is envisaged to be further clarified in their studies and reports. Effort will be done to reflect the plan in a GIS as pledged by the Department of Infrastructure. To this effect, two EEA staff members have participated in a 2-month training program arranged by the Department of Infrastructure along with their counterparts from the Department of Water and the Telecommunications Authority. In addition to these tasks the engineering consultant is entrusted with the supervision of the work of contractors on behalf of EEA that include:

- Conformance to the required codes, standards and specifications;
- Conformance to regulations of Asmara municipality concerning road and underground works;
- Conformance to environmental regulations regarding construction, and disposal of the replaced electrical equipment and material;
- Construction quality assurances through recorded acceptance tests;
- Verification of the requests from the contractor for alteration and/or adjustment to the specification, design and scope, and issuance of orders if required;
- Assistance in resolution of disputes, if any, between EEA and the contractor; and
- Design of suitable reporting procedures for all aspects of construction to ensure the EEA management and the Bank are kept informed of the project progress on a timely basis.

Mobilisation

EEA has already formed a project planning engineers, who have been working closely with the World Bank Mission and will do so with the engineering consultant. It is recommended that the first step towards comprehensive environmental management of the scheme for both Asmara Power Distribution and Rural Electrification components is the establishment of a full time Project Management Unit (PMU) that is affiliated with the EEA project team and the Ministry of Energy and Mines. This Unit should have a suitably qualified director, who should be an electrical engineer, with support staffs. Moreover, the Department of Energy will assign a Project Follow-up Expert, who will closely supervise and monitor the execution of the project focussing on policy and ESMMP matters. This expert will participate in all relevant meetings of the PMU. Among the duties of PMU related to environmental management and monitoring issues will include the following:

- Co-ordination of implementation of recommended mitigation measures;
- Co-ordination of specified monitoring programs;
- Collation of data from monitoring program and compilation of internal reports;
- Act as a point of contact for residents, via the local administrations;
- Collect, analyze and take appropriate measures for any grievances arising as a result of the project execution (see the RPF for procedural matters).
- Liase with the Department of Environment and other concerned bodies on all aspects of mitigation and monitoring of environmental impacts.

Excavation of trenches for underground cables:

Replacement of the distribution system in Asmara will require careful management especially with regard to traffic control, dust and noise suppression. Funds for excavation of

underground cable pathways and refilling remedial measures are not explicitly included in the budget estimate of the project. However, rough estimate is provided below. This is expected to be included in greater detail in the forthcoming engineering design. Moreover, the design should clearly indicate who does what among those to be involved in the construction work, i.e., EEA, foreign and local contractors as part of the management plan for the construction of the electrical works.

To minimise damages to the underground water and sewer piping, telecom cables the authorities have to be involved and maps should be utilised as much as possible. The PMU has to take lead action in setting a committee among these institutions to help follow-up the progress. Also it is likely that artefacts of archaeological significance may be found during the cable excavations or pole erections, as has happened before in the Mai Temenai area of Asmara. The plan is to inform the National Museum immediately and arrange for these to be collected promptly and/or divert the route as necessary.

Another issue of a major concern is whether or not resettlement or relocation of people (e. g., roadside vendors) will emerge during the construction phase. There are legal roadside vendors in some pavements of the streets of Asmara having small mobile shops. Whenever the pavements they are in are targeted for the underground cabling, they could be asked in advance to transfer to the opposite side of the road, thus, loss of shopping days can be negotiated. With respect to fixed shops, restaurants and other businesses along affected pavements, the owners will be advised to install temporary flat surface (wooden or metallic) crossings just in front of their respective doors. For more busy government offices or business complexes, EEA has plans to lay PVC hollow pipes just in front of the entrance doors, immediately after excavation to let the cables pass through after some time, and refill the same day.

Refilling and surfacing of cable pathways
After the underground cables are laid, T-joint outlets extended and any damages mended, urgency is required in refilling and surfacing the cable trenches to suppress the adverse environmental impacts that may be caused if delayed. It is advisable if the contractor who takes the responsibility to excavate also mends the system back. In many other projects it has been observed that the excavator leaves after the trenches are refilled with the soil excavated, leaving the asphalting or laying of pavement ceramics (and the corresponding budget) for the Municipality to do at a latter stage. This delay is the major cause for the negative impacts observed in the water project and has to be avoided in this project.

Cost estimation for Excavation and Backfilling of Underground cable Pathways
The Task Team approached Mr. Beyene, staff member of Studio Mchael Tedros and the best known quantity surveyor in Asmara, to estimate the costs for excavation and backfilling of the cable pathways. He provided the following breakdown of current costs for the specific activities.

Excavation and backfilling along pavements
1. Excavation----------80 Nakfa/m^3
2. Backfilling with selected material----120 Nakfa/m^3
3. Layering of Pavement Tiles----------200 Nakfa/m^2

Excavation and backfilling along asphalted road
1. Excavation----------80 Nakfa/m3

2. Re-asphalting----------400-500 Nakfa/m^2

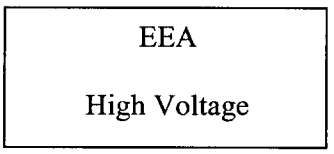
Excavation and backfilling along all weather road
1. Excavation ----------80 Nakfa/m^3
2. Backfilling----------50 Nakfa/m^3

The total length of the planned underground cabling in Asmara city centre is 40 km of which it is estimated that 24 km is asphalted and pavemented and 16 km is along all weather earth road. Same width of 60 cm and depth of 80 cm is assumed for all the cable pathways in the following table of cost estimate. From the 24 km of Asphalted and pavemented road, the cable pathway is assumed to be 23 km through pavement and the crossings of asphalted road adds up to 1 km.

Table 9-2 Estimated cost of excavation and backfilling of underground cable pathways

Cost component	Costs in Nakfa	Cost in USD
Excavation		
23 km pavement	80x0.6x0.8x23,000 = 883,200	
1km asphalt	80x0.6x0.8x1000 = 38,400	
16 km All Weather Road	80x0.6x0.8x16,000 = 614,400	
Backfilling		
Pavement	120x0.6x0.8x23,000 = 1,324,800	
Pavement tiles	200x0.6x23,000 = 2,760,000	
Asphalt	450x0.6x1000 = 270,000	
All Weather Road	50x0.6x0.8x16,000 = 384, 000	
Sub Total	**6,274,800**	**448,200**
Contingency 15%	**941,220**	**67,230**
Total	**7,216,020**	**515,430**

The contingency is made unusually higher to account for price escalation and compensation to damages that may be caused to underground water and telecom lines etc., during excavation. In addition EEA is planning to install the following mark every 50-m over the cable pathway as is being done in the Massawa similar project.



Establishment of double-fed loop distribution system and transformer cabins

The major motive for the double-fed loop distribution structure, instead of the radial now prevalent in Asmara, is to reduce power cuts to all customers during the construction work and in the future. Thus, it is to be welcomed. As its management plan is to be included in the engineering design, it is not timely to deal with it here. As recommended by the stakeholders' meeting, critical customers should in principle have their own backup genset at all times. For those who don't have at the moment the project will supply them with mobile generators and transformers. The PMU will identify those critical customers and protect their interests by negotiating with the project executioners.

As far as possible, the existing transformer cabins (note that they are all located in public places) will be upgraded and utilised in this project. There will definitely be the need for new cabin sites and public places shall be chosen for them. To the extent possible, private premises shall be avoided unless required by the owner, e.g, a large electricity consumer who is normally obliged to set aside a corner for the cabin inside his/her premises. For unavoidable transformer stations required in private premises, compensation shall be paid. The affected owners shall deposit a grievance to the EEA Project Office with a copy to the PMU for follow-up actions including compensation as per the Resettlement Policy Framework for this project.

Socio-economic impact of voltage conversion to customers

The PMU has to follow-up essential reports of the construction team to advise customers which could be potentially affected by the voltage conversion. The Construction crew has the obligation to inform the PMU beforehand concerning the measures of voltage conversion. By using the mass media the PMU has to prepare the public for voltage conversion, which emerged as a dire need during the socio-economic survey. This action will help reduce damages to customers equipment as well as make the necessary changes to the lighting systems or other equipment which used to operate with the archaic 127 V.

Advanced Information System

The Asmara Power Distribution project component is expected to contribute to the advanced information system planned by the Department of Infrastructure of Zoba Maekel by incorporating the plan in a GIS. Effort is in progress to do this for the water supply, sewer and telecommunication infrastructures of Asmara. However, this may not be completed in the initial planning stage of the power distribution project and thus the engineering consultant will have to rely on existing undigitised maps.

Voltage conversion has already been done in the peripheral areas of Asmara. In the socio-economic survey conducted in Asmara, it has been reported that 5 of 17 household respondents, 1 industry and 1 service provider had suffered property damages during voltage conversion. During the stakeholders' workshop there was a consensus view that lack of information for the public is to be blamed as 48% of those who converted say, they were notified before conversion, while 36% said they were not informed at all; the others did not remember. This does not sound good as customers should change also their lighting systems, etc., which implies some of the damages stated above might have been caused due to lack of information.

The main non-safeguard social impact, which require careful management plan, arising from the Asmara Power Distribution Project will be preparing the residents and businesses to shift to the upgraded power distribution system that may include changes within their premises, in lighting systems, electrical appliances and/or equipment at their own costs. Rural residents, besides covering collectively the distribution costs within their villages/urban centres have to pay individually for 1) connection from the nearest pole to their homes or businesses, 2) internal wiring within own premises and 3) electrical appliances for using the electricity.

The workshop participants recommended that an advanced information system to the public and private sectors is required to raise public awareness through media coverage, education materials, and having an information desk during the construction period. The PMU has to develop public information strategies along these lines.

Rural Electrification Component

It is also known that an engineering consultant will be engaged in the design, construction, supervision, completion documentation phase to assist EEA achieve the project objectives of the rural electrification component. The task details for the consultant is fully described in the terms of reference developed by the Bank in consultation with the EEA engineering planners. In particular, the consultant will study the suitability of Eritrean geology for low cost electrification and will assist in the procurement of goods and services based on the Bank procedures.

Institutional and Implementation Arrangements for Rural Electrification

Note that the villages/townships targeted for RE are shown in a map at the end.
The institutional and implementation agreements indicate that, EEA will be responsible for physical implementation of the rural electrification component. EEA has formed a project team, which will work closely with the engineering consultant. At least one Forman and two assistants shall also be assigned one each for the four RE project areas. The Project Co-ordinator within the Ministry of Energy will be responsible for the overall co ordination and monitoring of the rural electrification program.

The DOE will prepare and establish the business model for the co-operative distribution company in close collaboration with the relevant Governmental Ministries/Departments and with assistance from the various institutions and organizations, local and foreign consultants and staff seconded from other organizations as necessary. Establishment and implementation of the institutional framework will take place in two stages. In the first stage, two or three Electric Membership Co-operatives will be established as pilot (each including several villages). Selection of this first group will be based on several factors: strong interest from the villages involved, and the practical consideration of accessibility for supervision. Once the first group of Electric Membership Cooperatives is up and running, the project will implement a second stage, including establishment of the Electric Membership Cooperatives, covering a broader geographic area than the first set, and the establishment of the National Electric Membership cooperative Association. In all cases, the benefits and responsibilities of participation will be clearly explained to villagers and participation will be on a voluntary, "take-it-or-leave-it" basis. In no instance will a village be required to participate. At the end of the project implementation, if the pilot is successful, Electric Membership cooperatives

will be operational, the National/Regional Electric Membership Cooperative Association will be staffed and in a position to take over many of the support options from the government Project Management Unit. It will be excellent if this could be achieved. However, there are signs that the villages are less enthusiastic to establish cooperatives, despite the fact that the Department of Energy has developed basics of draft constitution for them and general guidelines on how to collect tariffs. In the first place, the educational level in the villages is very low and the members will have difficulty in keeping accounts and preparing reports.

The alternative approach of engaging the private sector phase by phase in the management of rural electricity services should also be tested at least in villages not prepared to form co-operatives. As a starting point the DOE should plan to train electrical practitioners for each village to be electrified which will take responsibility to conduct in-house wiring as this is not done by EEA staff as part of the project. Potential trainees are the demobilised youth who were engaged in the defence of the country. These trainees could be selected as EEA agents for the village who will take the responsibility to distribute and collect electric bills and conduct minor extension to new customer sites. They will get commission from EEA proportional to the services provided. They could also widen the scope of their services by engaging in other energy systems like distribution of LPG, kerosene or even renewable energy technologies. As rural electrification intensifies, these private practitioners could develop into *rural energy service companies* or even Independent Power Distributors.

The DOE in close association with EEA, the private sector, and academic institutions will monitor the institutional development and will also:

- Document the process and problems during pilot phase of establishing the program.
- Provide recommendations on how to improve the process.
- Discuss and recommend innovative schemes to make sure that vulnerable groups such as the extreme poor and minority groups are not left out from electrification
- Assess the initial socio-economic situation in participating towns and villages.
- Follow-up and document changes occurring as a result of the availability of electricity both positive (e.g., better health care and education facilities, establishment of new businesses, increased income levels) and negative.
- Provide recommendations to increase the benefits and reduce the negative impacts.

The institutional setting for Rural Electrification (RE) remains to be defined. To start with, pricing options for rural and urban markets remain to be studied, particularly the introduction of maximum demand and time of use pricing for large users, the extent and focus of subsidies, micro-credit for connections and the purchase of electric appliances.. In Eritrea, schemes to encourage community participation in rural development endeavours are relatively matured. As modern energy is a requirement for the envisaged Poverty Reduction Country Strategy, the need to intensify community participation for their potential to improve RE design, development and sustainability (both technical and financial) is paramount.

RE components will be appraised according to both socio-economic and financial criteria. Stark differences in results are likely to appear between sparse agricultural areas and towns or remote but potentially large consumers. Data requests for RE costs and benefits distinguish between low and moderate electric load densities, between lighting and motive power, between the substitution of fuels currently used and the new consumption that the availability of electricity at competitive prices will induce. Such data largely remains to be collected: it is

crucial in particular for EEA to analyse the induced power demand observed in the areas electrified 4 to 5 years ago.

EEA's role as a supplier of bulk power will be an excellent opportunity for EEA to increase electricity sales with virtually no increase in overhead cost and no need to provide financing. EEA's role as a contractor will generate income for the company without the need for EEA to finance projects. However, EEA will be competing with private sector companies and thus will be forced to reduce costs while increasing attention to customer needs.

The major policy issue for the Rural Electrification component is the need for the government to produce an electrification access policy, defining indicators and setting targets. This would both signal the government's commitment to expanding access to electricity and provide a benchmark against which to measure the effectiveness of and electricity access programme based on the outcome of the electrification study mentioned above.

Capacity Building for Environmental Management and Monitoring Plan and Cost Estimates

As described in the earlier section of this ESMMP, the Asmara Power Distribution and Rural Electrification project has a Capacity Building Component to finance, develop and strengthen the private and public services sector linked to enhancing the objectives of this project. The capacity building programmes earmarked for EEA staff linked with both components of the project are embedded in the project formulation, financing and activities, thus will not be treated here.

Quite extensive capacity building efforts have been proposed for the Rural electrification Component. This would take the form of primarily identifying trainable members of civil society in the local communities, local NGOs and public service workers to become service providers to the Village Administrators, Village Development Committees and/or Electricity co-operatives and Private energy service companies. This includes providing training and technical assistance to them in the areas of environmental and social impact assessment, screening etc. Members of the VAs and private service companies associated with them would themselves be trained on how to screen their sub projects and implement their ESMMP's and managing the RPF process as outlined in the framework.

At the moment, it is envisaged that the capacity at the rural level to provide electricity related service is limited. The Zoba Representatives of the Departments of Energy and Environment will play a lead role in the capacity development effort for the Environment and Social Impact Assessments and the screening processes including for the RPF and in supporting the PMU. Their capacity would be greatly enhanced by this project.

The training program proposed below is directly relevant to the needs of the VAs, Electricity Cooperatives, and/or energy service providers and the regional offices of the relevant ministries with regard to environmental and social assessment and environmental policies and procedures. It will be provided through national experts from the Departments of Energy and Environment.

The ESA, the Resettlement Policy Framework, typical Village Electricity Management Plan, would be reviewed in the training program so that participants are aware of their content and the responsibilities outlined in them for various parties.

The training programme will also finance activities to strengthen the institutional capacity of the DoE /EEA/PMU in monitoring, evaluation, research and policy development and by staff training in strategic areas.

EEA level training
Together with the engineering consultant, the PMU will arrange for the training of EEA technicians and from electrical contractors to be involved in the reconstruction work. **A budget of USD$ 53,000 is earmarked for this task from the project funds.**

Proposed Training Program for PMU/DoE Staff	**Duration**
Environmental and social assessment process	**3days**

- Review of standard RE designs including cheaper versions
- Screening process
- Identification of impacts
- Design of appropriate mitigation measures
- Rationale for using screening form and environmental and social checklists
- Preparation of terms of reference for carrying out ESA
- How to review and approve project proposals
- The importance of public consultations in the ESA process
- How to monitor project implementation
- Case studies

Environmental and social policies, procedures and guidelines 2 days

- Review and discussion of Eritrea's environmental policies, procedures, and guidelines.
- Review and discussion of the Bank's safeguards policies.
- Review of ESA, ESMMP, and RPF plans.
- Collaboration with institutions at the sub Zoba, Zoba and national levels., e.g. Department of Environment
- Guidelines on effective measures to seek meaningful and active compensation and participation of project affected persons (pap's), especially, vulnerable groups.

Selected topics on environmental protection 1 day

- Land use, land degradation and soil erosion
- Flood protection
- Waste disposal
- Ground and surface water management
- Country poverty reduction strategy

For the local communities, the Village Administrator (VA) and their staff/assistants would be trained based on the training program below to successfully implement their roles and responsibilities as required in this ESMMP in particular but also the RE project in general. Subsequently, they would then train members of their communities on the issues raised in the training program. By so doing significantly increasing environmental and social awareness throughout Eritrea as re proceeds.

The below training program is consistent with the needs of the VA's to meet their responsibilities as stated in this ESMMP.

Proposed training program for VA's and their staff/assistants

	Duration
Environmental and social assessment process	**2 days**

- Review of standard RE designs
- Screening process
- Use of screening form and environmental and social checklists to identify impacts and mitigation measures
- How to monitor project implementation
- Case studies

Environmental and social policies, procedures and guidelines	**2 days**

- Preparation of application for village electrification
- Review of ESMMP
- Optimum selection of the right of way for the electric poles
- Use of RPF and environmental and social screening forms
- Preparation and implementation of compensation plan.
- Guidelines on effective measures to seek meaningful and active compensation and participation of project affected persons.

Selected topics on environmental protection	**1 day**

- Land use, land degradation and soil erosion in their local community
- Protecting the interests of the utilities and users.
- Environmental protection of water and forest resources.

Training of village level electrical practitioners

EEA and Department of Energy staff will train general practitioners of elementary electrical installations. This will include simple extensions beyond the kWh meter, in house wiring, meter reading, bill administration, etc. The duration of the training shall be at least two weeks and the trainees should ideally have some technical background. The trainees shall be selected from each of the four project areas and should preferably be at least one from each village/township targeted.

Training Methodology

1. Training of EEA/DoE/PMU staff. A suitably qualified international consultant would do the training of these groups.

2. Trained Department of Energy/Environment trainers will now train VA's and their staff/assistants on a "as is required " basis.

3. Training of service providers - at the moment it is envisaged that the capacity in the local communities to provide service providers, including basics of electricity, in-house wiring, and bills administration who will be required to work with VA's will be non-existent or minimal. Therefore, to significantly build local capacity, EEA/Department of Energy trainers will identify trainable people drawn primarily from members of civil society in the local communities, demobilised soldiers, and public service workers who would then be trained (based on the same training program for VA's) by the DoE trainers to become service providers to the VA's providing technical assistance to assist fulfil their responsibilities.

Cost Estimates

The cost estimates are based on the assumption that the training program for VA and their staff/assistants and training of service providers will be held at the Zoba levels. Resource persons are likely to come from other parts of the country and therefore will require travel allowances; participants will come from the local community and attend during the day only but will receive a per diem. These estimates include an allowance for travel expenses and all costs of the trainers. It is proposed that the training program for the VA staff will be implemented four times a year, at least once in each quarter in each Zoba over the first two years of the project cycle and complimentary to the RE construction program.

The Total Training Budget is estimated at US $ 75,000.

Monitoring Indicators and Plan with Costs

Responsibilities for Monitoring and Evaluation of the Mitigation Measures would be assigned as follows:

Department of Energy - This Department will independently monitor and evaluate the whole project execution through its project Officer and Supportive Committees. In particular it will be largely responsible for the ESMMP processes and monitoring and evaluation measures of the RE component. **To enable it conduct this task, it will require USD 50,000.**

Project Management Unit (PMU) – The PPU and the international consultants will be fully responsible for the follow-up and co-ordination of the monitoring and evaluation of the ESMMP for Component I and for the follow-up and documentation of the environmental and social screening process and monitoring carried out by the VA's and their assistants for Component II.

Village Administrators (VA's) – will be responsible for monitoring of (i) the environmental and social assessment work to be carried out on its behalf by service providers; (ii)

overseeing the implementation of the compensation plans; (iii) the facilitation of the works during the construction process; (iv) over-viewing the activities of EEA, the Electricity Co-operatives and/or energy service companies in the management of electricity services after electrification. The VA will be assisted in performing these monitoring duties by their service providers.

Department of Environment (DoE) - The committee representatives of the Department of Environment will perform an enforcement monitoring role supported by the PMU (who would perform a self monitoring role) with particular focus on monitoring cumulative impacts of construction program of both project components to ensure that individual mitigation measures are effective at the cumulative and national levels.

Monitoring activities by the PMU will be continuous while that of the VA's and DoE will be performed periodically preferably at quarterly level.

The arrangements for monitoring would fit the overall monitoring plan of the entire project which would be through the PMU and the Department of Energy and VA's.

The objectives for monitoring are two folds.

1) To alert project authorities and to provide timely information about the success or otherwise of the EA process outlined in this ESMMP in such a manner that changes to the system can be made if required.

2) To make a final evaluation in order to determine whether the mitigation measures designed into the project activities have been successful in such a way that the pre- project environmental and social condition has been restored, improved upon or worst than before.

A number of indicators would be used in order to determine the status of affected people and their environment (land being used compared to before; number of villages/townships electrified in a Zoba/sub-Zoba; compared to before; level of participation in project activities compared to before; time series statistics of the domestic, commercial, and industrial customers; improvement in social facilities like health clean water sources, schools compared to before; how many people employed than before etc). Therefore, the project's EA process will set three major socio-economic goals by which to evaluate its success:

- Affected individuals, households, and communities are able to maintain their pre-project standard of living, and even improve on it;
- Has the pre-project environmental state of natural resources, bio-diversity and flora and fauna, been maintained or improved upon, and
- The local communities remain supportive of the project.

In order to assess whether these goals are met, the project will indicate parameters to be monitored institute monitoring milestones and provide resources necessary to carry out the monitoring activities.

The following parameters and verifiable monitoring indicators will be used to measure the EA process, mitigation plans and performances;

Component I

- Adherence to the construction plan by contractors
- Adherence to the procurement plan of goods and services
- Length of underground cable pathways excavated per day
- Number of road side vendors displaced any loss of business days
- Number of complaints on restrictive access to business areas, urban traffic, land, property, etc
- Extent of private land, garden requirement for transformer stations
- Rate of backfilling of excavated surface
- Extent of dust and dirt
- Extent of damage to other underground systems
- Number of sensitive customers to power cuts and solutions presented
- Press coverages, consultations, pamphlets distributed, etc to inform the public to prepare them for the voltage conversion
- Extent of any damages caused to customers property during the transition to the new voltage levels
- Grievances and/or complaints reported and accommodated
- Compensation measures executed to affected people
- Number, location of old systems disposed and treated environmentally friendly
- Number of trainees of EEA local electrical contractors.

Component II

- Number of village administrators (VA's) who have successfully received EA training in screening methods etc.; Evaluate the training content, methodology and trainee response to training through feedback;
- Numbers of energy service providers and village electrical practitioners trained;
- Number of VA's who have adopted the ESA process as required by ESMMP; evaluate the rate of adoption;
- In how many VA's planning stages is the EA checklist and screening form applied?; Are the numbers increasing and at what rate?
- What are the main economic and social benefits that rural customers derive from the use of electricity?
- Efficiency of VAs in mobilising their village/township communities in financial and labour contribution to the project;
- Number of villages/townships electrified per year;
- Any damages to agricultural crops and trees cut;
- Number of people compensated for any loss of property or damages as per the RPF
- Any incidents from landmines to the construction crew;
- Number of households in a village/township that have failed to electricity connection because of extreme poverty;
- Number of businesses established in a village before and after electrification;
- How many villages have established electricity co-operatives and how many are being served by EEA employees, EEA service agents, and rural energy service companies?
- Overall assessment of (i) activities that are going well (ii) activities that need improvements and (iii) remedial actions required;
- Is the screening process identified in this ESMMP working well?

- Based on the performance of the re construction program review, what, if any changes to the ESMMP or RPF, and additional training capacity building, are required to improve the performance of the ESMMP and the RPF implementation?

For RPF the Following Indicators:

- Each negatively affected individual will have a compensation dossier recording his or her initial situation, all subsequent project use of assets/improvements, and compensation agreed upon and received.
- The project will maintain a complete database on every individual impacted by the project land use requirements including relocation/resettlement and compensation, land impacts or damages
- Percentage of individuals selecting cash or a combination of cash and in-kind compensation,
- Proposed use of payments
- The number of contention cases out of the total cases
- The number of grievances and time and quality of resolution
- General relations between the project and the local communities

The following indicators will be used to monitor and evaluate the implementation of resettlement and compensation plans;

Verifiable indicators	
Monitoring	Evaluation
Outstanding compensation or resettlement contracts not completed before next agricultural season.	Outstanding individual compensation or resettlement contracts.
Communities unable to set village-level compensation after two years.	Outstanding village compensation contracts.
Grievances recognised as legitimate out of all complaints lodged.	All legitimate grievances rectified
Pre- project production and income (year before impact) versus present production and income of affected people.	Affected individuals and/or households compensated or resettled in first year who have maintained their previous standard of living at final evaluation.
Pre- project production versus present production (crop for crop, land for land, forest for forest).	Equal or improved production per household.

Administering the RPF will require at least USD 30,000 for the Asmara Power Distribution and USD 20,000 for the RE component, thus in total USD 50,000

Table 9-3 Summary of estimated costs for the ESMMP and RPF

Project activity	Estimated costs in USD
Establishment of PMU	238,400
Enabling DoE fulfil commitments in the project (training, monitoring and evaluation...)	50,000
Training for EEA employees	53,000
Training for VAs, ZAs and service providers	75,000
Cost of underground cable-way excavation and refilling	515,430
Implementing the RPF	50,000
Total	**981,830**

Note: The budget for training for EEA personnel is explicitly stated in the project document but not for the others, implying that additional budget is required.

Consultation Plan

The purpose of consultation is to seek the participation of communities, NGO's and all other stakeholders in the project activities thereby introducing transparency and accountability in the project. During the project preparation and implementation stages, the opportunities for effective consultation and participation were conducted during the preparation of the Environmental and Social Assessment Report that is this report at a stakeholders workshop.

More consultations are planned to take place:

- During the implementation of the ESMMP for both project components, and
- During the preparation of Resettlement Policy Framework when the Environmental and Social Screening exercise is being conducted.

Public participation and consultations would take place through meetings, radio programs, request for written proposals/comments, filling in of questionnaires/forms, public readings and explanations of project ideas and requirements, making public documents available at the concerned government offices and Authorities, public libraries for Component I. For Component II, the public documents shall be distributed to Zoba, sub-Zoba, and village/township level administrative centres, and libraries and would be in the local languages. These measures would take into account the low literacy levels prevalent in these communities by allowing enough time for responses and feedback.

The consultation plan will be monitored by the DoE and the EEA/PMU who will set their own verifiable indicators to assess the degree of participation of the key stakeholders in sub project preparation by reviewing the relevant project documents and progress reports. The DoE will analyse the recommendations and facilitate for execution, consistent with this plan.

Table 9-4 Summary of ESMMP for the Asmara Power Distribution component

Potential Social and Environmental Negative Impacts	Mitigation Measures	Monitoring Measures	Phase/Stage	Responsibility	Costs
Slow excavation and refilling of underground cable pathways, associated dust and dirt	Urgency required in excavating and refilling to reduce impact on urban traffic and peoples comfort	Prepare construction material beforehand. Same subcontractor should do the work. Set time limits	Ongoing throughout the construction period.	PMU, Consultant regularly and DoE occasionally	Over USD 515,000 for cost of excavation and refilling
Denial of or restrictive access to economic resources, land, fodder, property, building, roadside vendors	Use public property and avoid private ones. Use temporary businesses crossings. Move roadside vendors to opposite side of road. Implement safeguard policies whenever OP 4.12 is triggered.	Determine if affected people have restored their pre-project economic conditions, or not, by checking and evaluating on a periodic basis, using verifiable indicators set out in Section M of RPF.	Ongoing throughout the construction period.	PMU, Consultant regularly and DoE occasionally	USD 30,000 for Resettlement and Compensation Plan
Damage to other underground systems, such as water pipeline, sewerage and telecom lines	Use the corresponding maps of these systems, prepare GIS for the underground systems including that of electricity. Establish stakeholders' technical committees	Refer to the Department of Infrastructure Regulations to avoid damages. Monitor and register the immediate remedial measures taken.	Ongoing throughout the construction period.	PMU, Consultant regularly and the relevant Departments	Materials and labour from relevant Departments in addition to the above
Extended power cuts to critical customers and others	Convert the radial to double-fed loop structure. Use mobile generators and transformers to critical customers	Record any extended power cuts and solutions adopted. Grievances complaints reported and accommodated	Ongoing throughout the construction period.	PMU, Consultant regularly and the relevant Departments. Customers	Project funds, PMU Budget
Socio-economic impact of voltage conversion to customers	Through extensive mass media coverage prepare the customers to the voltage conversion	Press coverages, consultations, pamphlets distributed, etc to inform the public to prepare them for the	Just before voltage conversion in an area	PMU, Consultant, DoE	From project funds

		voltage conversion			
Management related	Establish the PMU		At the start of project mobilisation	EEA, DoE, consultant	USD 238,400
Under capacity of EEA	Conduct training of EEA personnel	Number of employees trained	In the first two years of project execution	EEA, consultant	USD 53,000
Positive benefits of the project	Assess the problems associated with the old power system and refine indicators for improvement	Record the positive benefits to customers and match with the typical indicators stated	Whenever and after the new power system becomes operational	PMU, consultant, and occasionally DoE	From PMU Budget

Table 9-5 **Summary of ESMMP for the Rural Electrification component**

Potential Social and Environmental Negative Impacts	Mitigation Measures	Monitoring Measures	Phase/Stage	Responsibility	Costs
Damages to agricultural products	Minimize right of way through irrigated farms. Conduct construction work during the dry season	Number and extent of damages recorded. Compensation plans implemented	Ongoing throughout the construction period.	PMU, Consultant regularly and DoE occasionally	USD 20,000 earmarked for compensation plans of RE
Vegetation damage, cutting of trees and branches, habitat loss along right of way, access roads and around substation	Utilise appropriate cleaning techniques Maintain native ground cover beneath lines Replant disturbed sites Manage right of ways to maximise wild life benefits, detour from plantations	Complaints and grievances reported and verified. Number of compensation plans effected	Ongoing throughout the construction period.	PMU, Consultant regularly and DoE occasionally	USD 20,000 earmarked for compensation plans of RE
Cultural heritages and archaeological sites	Select right of ways to avoid known cultural and archaeological sites. For underground discovery discontinue work and inform the relevant Authority	Release information of known sites to the contractors. Record any discoveries and contacts made with the National Museum	Ongoing throughout the construction period.	PMU, Consultant regularly and the National Museum	
Under capacity of VAs, ZAs, Electricity co-operatives and rural energy service providers	Provide training and instruction manuals in the language they understand	Number trained. Ensure that the environmental and social assessment form is filled for each targeted village	Area specific training should be conducted before construction work in that area begins.	PMU, DoE, the Department of Environment	USD 75,000 and the $50,000 fund allotted for DoE expenses
Securing an optimum right of way	Involve local administration and people	Extent of consultations conducted	At the start of project mobilisation for each area	EEA, DoE, RE Support Committee	PMU and DoE funds
Some areas may be mined	Collaborate with the Demining Agency to	Mine Clearances obtained for the	Before construction begins in the suspected	PMU, DoE and the National Demining	

	ensure mine clearance beforehand	suspected areas	areas	Agency	
Poverty related	Raise popular awareness on micro credits and income generating activities, self-help schemes, etc.	Ensure that no member of a village community is left unelectrified because of poverty	Ongoing throughout the construction period.	PMU, DoE, VAs, ZAs	
Management related	Introduce energy service companies, EEA agents and/or electricity co-operatives	Number and level of capacity developed to manage rural electricity services	Ongoing throughout the post-construction period.	PMU, DoE, VAs, ZAs	From the DoE, PMU and Training funds of the project.
Positive Benefits	Refine guidelines and indicators for assessing positive benefits	Villages electrified, post electrification income generating activities etc.	Ongoing throughout the post-construction period.	DoE, VAs, ZAs	

10.LIST OF REFERENCES

Albert Mumma, 2003, *an Appraisal of the Laws and Regulatory Frameworks for the management of the Environment and Natural Resources in Eritrea*, GOE and UNDP, Asmara Eritrea.

Department of Urban Development (DUP, 1998), *Urban Development Standards and Guidelines*, Asmara, Eritrea.

Elias Tesfamariam (2000) Challenges and Opportunities in Rural Energy Development, Proceedings of the Eritrean National Policy Seminar. Asmara, Eritrea

Eritrea Demographic and Health Survey (EDHS 1995), National Statistical Office and Macro International Inc., Calverton, Maryland, USA

Eritrea Demographic and Health Survey (EDHS 2002), National Statistical and Evaluation Office and ORC Macro, Calverton, Maryland, USA

Government of the State of Eritrea, (2001), *Transitional Economic Growth and Poverty Reduction Strategy 2001-2002*. Asmara, Eritrea

IVO Power Engineering and Electrowatt Engineering Limited, (1998), *Distribution and Voltage Conversion Study of Asmara* in Collaboration with EEA.

Mumma, A. *An Appraisal of the Laws and Regulatory Frameworks for the Management of the Environment and Natural Resources in Eritrea*. Asmara, Eritrea - a study sponsored by UNDP and Government of Eritrea.

Semereab Habtetsion and Zemenfes Tsighe (2001), *Renewables and other Energy for Rural Development in Eritrea; Part I.* AFREPREN Publications, Nairobi.

Semereab Habtetsion and Zemenfes Tsighe (2002), *Renewables and other Energy for Rural Development in Eritrea; Part II.* AFREPREN Publications, Nairobi.

UNDP and Government of Eritrea, (2001), *Common Country Assessment* Report. Asmara, Eritrea

UNDP and Ministry of Agriculture (2002), *Development of an Agricultural Sector Policy and Strategy,* Asmara, Eritrea.

World Bank. 1996. *Eritrea - Poverty Assessment*. Report No.15595-Eritrea. Washington.

World Bank. 2000. *African Development Indicators*. Washington.

11.APPENDICES

11.1 Task Team Members

Name	Organisation	Qualification	Position Held
Semere Habtetsion	Dept. of Energy	PhD in Physics	Director, Chairman
Fesehatsion G. Medhin	EEA	B. Sc. in Elec. Eng.	Senior Advisor, member
Amanuel Andebrehan	Ministry of Energy , HQ	M. Sc.	Planning and Statistics/PR
Muluberhan G. Yohans	Dept. of Environment	B. Sc.	Environmental audit, member

11.2 List of Contacted People

Name	**Institution**	**Position**
1. Mr. Abraham Woldemichel	Eritrean Electric Authority	General Manager
2. Mr. Samuel Baire	Department of Energy	Dir. General
3. Mr. Ghirmai Tsige	Tech Manager	Telecom. Service of Eritrea
4. Mr. Semere Russom	Zoba Maekel	Governor
5. Mr. Kahsai G.Hiwet	Zoba Debub	Governor
6. Mr. Semere Abay	Zoba Maekel	Director, Department of Infrastructure
7. Mr. Medhanie Estifanos	Ministry of Public Works	Director of Urban Development
8. Mr. Solomon Haile	Ministry of Agriculture	Head, Planning & Statistics
9. Eng. Fessehatsion G/medhin	EEA	Adviser to the General Manager, EEA
10. Dr Yosief Libsekal	National Museum	Dir. General
11. Mr. Abraham Berhe	Distribution Division ,EEA	Director
12. Mr. Rezene Russom	National Museum	Div. Director cultural Heritage
13. Dr. Zemenfes Tsige	Asmara University	Dean, College of Social Sciences
14. Mr. Mulubrhan G.Yohannes	Department of Environment	Expert
15. Mr. Michel Negash	Dep't of Water resources	Director
16. Eng G.Kidan Haile	Asmara Water Supply	Head, water supply infrastructure

11.3 Appendix A. Primary Field Data for Urban Planning

Primary data have to be collected during site analysis from the following aspects:

i. Physical resource inventory:

- Land form and vegetation cover this includes forests and trees, which can be conserved. Their type and locations can be also well identified.
- Geology and soil type should be well identified. Soil types dictate the land use type and location. E.g. Area suitable for construction or for recreation purposes.
- Hazardous areas i.e. swampy, cliffs, eroded areas, earthquake and flood prone areas can be identified.

ii. Hydrological investigation:

This includes water bodies available e.g. rivers, ponds and their capacity, water streams and drainage patterns. Information on hand pumps, piped water source, distribution, quantity and adequacy have to be collected. Information on ground water reserves has to be gathered as well.

iii. Demographic data

- Size of population and composition
- Age- composition
- Migratory strength and trend
- Growth rate and population pressure

iv. Physical infrastructures

- Water supply system in the surrounding area
- Sewerage/sewer system available for domestic waste water
- Discharge points, treatment sites, and oxidation ponds for waste waters
- Storm water drainage system whether it is a combined or partial or separate system, surface or piped system
- Refuse collection system and dumping sites
- Electrical power distribution lines
- Telecommunication services available i.e. Telephone lines etc.

v. Social infrastructures

- Education facilities nearby. E.g. kindergarten, elementary school junior secondary and high schools.
- Clinics, health centres and hospitals
- Market
- Shopping centres
- Telephone services
- Churches and Mosques
- Hotels, restaurants, clubs, cafe etc.

- Sports and recreation
- Public institutions

Design of the master plan

Most Eritrean towns lack updated plan and some do not have any. With the increasing number of urban inhabitants and influx of returnees it is natural that the demand for such plans should be a matter of priority for the new nation as it emerges from war.

Before an attempt is made in drawing up a comprehensive plan, socio-economic data and present and future demographic growth of each city must be made available and well studied. Drawing a physical plan alone is not adequate. The population distribution, Income categories, family size must be well understood in the planning phase. Planning integrates both the social and physical aspects.

The plan must first layout the physical infrastructure. This preliminary step should include the following:

1. Land designation for residential and commercial use.
2. Land designation for avenues, streets, roads and alleys
3. Electrical supply and distribution grids.
4. Water supply and piping system for running water.
5. Efficient drainage system.
6. Efficient sewerage system
7. Water treatment system
8. Telephone lines distribution system.
9. Land designation for institution and public services.
10. Land designation for sports and recreations.
11. Land designation for private use.
12. Land designation for public use.
13. Land designation for green belts.
14. Land designation for open markets and shopping centres.
15. Land designation for cemeteries.
16. Land designation for churches and mosques.

Power supply and communication services are more becoming necessities rather than luxury even in small towns. Therefore even if immediate services of such kind are not ripe simply because of financial reasons, space provision for future installation must be taken into consideration.

11.4 Appendix B: Catalogue Of Some Eritrean Archaeological Sites

NAME NATURE OF	LOCATION	SITE/Description
Adi Amusat	Zoba Ma'ekel S.West of Qushet	Settlement Ruins
Adi Qontsi	15kms.West of Asmara Zoba Ma'ekel	Settlement ruins
Adi Ghiorghis	Region of Adi Qeyeh near town of Aba-Selama	Ancient tomb
Adi-Hefut	2km North of Mai-Ayni Zoba Debub	Rock Art
Adi Gramaten	Some kms. West of Kesskesie Zoba Debub	Inscriptions + Ruins
Adi Qushet	S. West of Asmara Zoba Ma'ekel	Settlement Ruins
Adi-Lessim	3km North of Asmara Zoba ma'ekel	Settlement Ruins about 600 meters long
Adi Nefas	Dekemhare (Dembezan)	Ancient site
Adi Nefas	Northern of Asmara	Historical site
Adi Qeyeh	Zoba Debub	Obsidian tools
Adi Shemaghele	5km North West of Asmara	Settlement Ruins
Akhria	Asmara Zoba Ma'kel	Ancient site
Anteret	Goash Setit (Tesenney)the village is on North of the site	Ancient tombs
Arabda	Gash Aqordet	A.Settlement
Arabje	Gash Aqordet	A.Settlement
Be'atti Abraham	Amba Soira near the ruins of Hara Morgasen Zoba Debub	Settlement + Ancient tomb
Balkai	Gash Barka	A.Settelement
Be'atti Abay Hagos	North of Adi-Qeyeh in the Vallyey of Hembaaaarten	Open-shelter and ruins of pillars
Beat HalHal	Debre Bet (Mariam Tselam)	Rock art
Baraknah	About 15km South of Sen'afe Zoba debub	Medieval church
Beleza	8km. North of Asmara Two ruins one found North of the lake anther on the South Zoba Ma'ekel	Many fragments of artifacts, grinding stones, pottery etc.
Bet- Aba Hanni	North of the great site of Der'a Zoba debub	Antique ruins of settlement area
Bet Gheorghis	4kms. of Asmara Zoba Ma'ekel	Habitation site
Bihat	On the plain of Adi-Gulti S.s.W. of Metera, West of Berakit Zoba Debub	Ancient disappeared residence with ruins Pillars. The church of Kidanemhret is also surrounded with ancient ruins.
Da'ero Qawlos	Zoba Ma'ekel 8kms. S. W. of Asmara	One of the most important Rock-Arts in Eritrea
Debre –Be'at	Around Aratu (Marya Neri)	Ancient residencies and ancient tombs.
Debre –Qedus-Mameruk	North of debir Be'at near Keren- Zoba Anseba	Tombs with oblisks and inscriptions a very large and extensive site.
Dahlak-el Khebir	Island of Dahlak khehbir Semenawi Qeyeh Bahri	Ruins of antique city with large necropoleis
Demba –Mec	South of Adi Ugri Zoba Debub	Habitation site
Der'a	Three hours drive North of Adi –Qeyeh on the way to Halai	A very large site with ancient pillars, a churches (6th century

		A.D) and fragments of inscriptions
Debarwa	At 40kms. S. of Asmara near the church of Enda-Mika'el Zoba Debub	The capital of Bahre negash
Debre-Tsion	4km. N. of Asmara Zoba Ma'ekel	Habitation site
Deqemhare	42km.S of Asmara near the road that goes to Seghenyti.The site is 700m. from North to South 400m.from West to East. Zoba Debub.	Settlement Ruins
Debdeb	Shimezana districtof Wodi Ekele- Meshal 200km. From the main road 9km. South of Sen'afe Zoba debub	Ruins of a sphina with sabean inscription broken stelae with decrations
Debre Bea at Urit (□ Yθ)	Maria Tselam	Historical Site Ancient Settlement
Desset	Mitsewa'e	Mounds(about one hundred)
Digdigta	Addi keih	Archoelogical site
Dongolo Mai Tombuk	Endagirgis(Zoba Debub)	Ruins
Eedit	Shimezana between barakna and Galebb Zoba Debub	Inscriptions Rock engravings
Elit	Gash Barka	Settlement
Emba Tchilai	South of Adi keih	Rock paintings
Enda-Aba Metta	16km. South West of Debarewa	Ancient basin and inscriptions in Ghe'ez.
Ena-Gaber-Ona	between Tedrer and Temeza on the side of river mereb Zoba Debub	Settlement Ruins
Enzlal	Habab, rora Asgheda about 16kms.South of Baqla Zoba Anseba	Probably an ancient temple containing Sabean inscriptions
Eyilu	20km.South of Asseb on the road towards Raheita Debubawi-Qeyeh-Bahri	Tombs
Fekaad Nawd	Nakfa	Tomb
Fegya	Hawatzu (North of Addi Keih)	Rock painting
Feqya	South of Metera about 3km North East of Bihat	Ruins of an ancient temple
Fode	Gash Barka	Caves
Foru	Reigion of Aratu Zoba Anseba	Settlement ruins
Gabaz	South of Adulis Semenawi-Qeyeh Bahri	Settlement ruins
Gheza Irab	Gash Barka	Settlement
Gash River	Tessenei 35km. Sssouth of the river Gash	Ancient settlement
Gerefit	Gash Barka	Ancient site
Golo	On the hills of ambasoira Zoba Debub	Caves and Tombs
Gobo ona	Serejeka (Dembezan)	Historical Site
Gogni	Gash – Barka	Ancient Site
Grat-Mah-derhe	South of Mai-Turub North of Amba helya 2km North of Anan Village Zoba Debub	Temples Ruins and ancient residences
Godafo	Dekemhare (Dembezan)	Ancient Site
Godayf	Southern Asmara Zzoba Ma'ekel	Prehistoric Site stone-tools
Guddo-Ona	At 10kms. North West of Asmara near Tsa'eda kristian	Settlement ruins
Guna Guna	Sen'afe region Zoba Debub	Ancient church
Gura	Suburb of Deqemhare near the Airport Zoba Debub	A number of antique sites
Hachel Ona	5km. North of Asmara about 2km of Mai –Melaise Zoba Ma'ekel	Settlement Site
Hadamu	North of Asmara Zoba Ma'ekel	Settlement Ruins
Halhale	Near Debarwa Zoba Debub	Toms
Ham	Shimezena West of Zelambessa	Antique sites medieval church and

		mummies
Hares,Feres	Gash Aqordet	Turkish Ruins
Haz-Haz	Asmara Zoba Ma'ekel	Ancient Site
Hindika	Gash Aqordet	Turkish Ruins
Keskese	2kms.North of Ama-Tarika Between Sen'afe and Adi-Qeyeh Zoba Debub Hawatzo (Northof Adi Keih)	Ancient residence colums with inscriptions
Kedena-Kersi-Ase	Gash Barka	Ddirt floor bearing charcool
Kofit	Gash barka	Turkish ruins
Kondo-Gera	Gaash Aqordet	A.Settlement
Korkoda	Senafe (about 6km East)	A.Settlemernt (bottle field Alula)
Kisad-Imba	Asmara suburb Zoba Ma'ekel	Ancient Site
Kwazen (adi-Saka)	Near Asmara500-600m South East of	Tombs
Kodemas Amba	Debre Sie	Settlement Ruins
Koken	Agordat	Pre-Historic Site caves
Kuduy	Rora Laba	Eengravings
La'eli'O	Near Qohaito North West of Goreita 200m from La'elio village. Zoba Debub	Temples, pillars and Sabena inscription
Margebla	13kms.South of Asseb Debubawi Qeyeh Bahri	Obsidian tools and ruins
Metera (Belew-Kelew)	South of Sen'afe Zoba Debub	Settlement ruins setle one of the rare excavatel sites in Eritrea.
Mai-Duburce	Zoba Debub	Rock Art
Mai-Demnet	Asmara Suburb	Rock Art
Mai-Girar (durko)	Near the sub-zone office of Durko	Ancient Site Rock painting
Mai-Mefales	Asmara Suburb Zoba Ma'ekel	Settlement
Mai- Melatse	Asmara Suburb	Settlemrnt
Mai-Melegen	Asmara suburb	Settlement ruins
Mai-Tsadqan	Asmara Suburb	Settlement ruins
Mai-Turub	5km.west of Keskese Zoba Debub	Secular and relligious ruins
Mai-Tchehot	South East of the train station at Asmara Zoba Ma'ekel	Groups of ruins
Mai-Temenai	Asmara Zoba Ma'ekel	Ncient site 400 BC
Medri-Tsion	20km. North of Asmara Zoba Ma'ekel	Tomb-pre-christian and bones
Me'rad Worqi	Half way between Bihat and Feqya Zoba Debub	Antique site
Mehlab	hrs from Gheleb mensa'e Bet Eshakan Zoba-Anseba	Tomb
Mnah	Adi-qeyeh region in the Abenehe vally South of zeban Tahsas at the foot of Zeban Morora Zoba Debub	Ruins
Messalib	Between Teder and Temeza Zoba Debub	Prehistoric Stone tools
Meshkul	Gash Aqirdet	Turkish ruins
Mezabir	Hauatzo (North of Adi Queih)	Ancient structur , Sewage cut of stone
Miesar Feres (M□.∴Ξ ⊄⊇])	Debre Beat (Maria Tselam)	Historical site
Naka (Habarom)	Gash Aquordet	Turkish Ruins

Naqfa	Zoba Anseba	Topmb Antique and Recent Sites
Ona-Andom	N.N West of the village Ona Andom Zoba Debub	Hundreds of ancient wells
Raheita	60km. S.of Asseb S. East of Margebla near the Djibouti frontire Debubawi Qeyeh-Bahri	Settlement Site grinding stone ancient Osteris
Rehya	Zoba Debub	Ruins
Rora hayar	N.West of Keren Zoba Anseba	Rock Art
Rora Laba	Zoba Anseba	Several Steles with Sculptured loins secular construction
Rora Maret	Zoba Anseba	Ruins, rock Art obsidian tools
Salham Nahara	Half way between Adi-Qeyeh and Der'a Zoba Debub	Secular buildings
Sasel	Gash Barka	A. Settlement
Sherek	Debre Beat (maria Tselam)	Historical site
Shilko	Gash Barka aqordet	Settlement (bottle field Alula)
Shimaglay	Rora Bakla	Historical site
Shumbare Kaba	Gash Barka	A. Settlement
Tegara	Gash Aqordet	Settlement (bottle field alula)
Temarere	Gash Aqordet	Turkish Ruins
Tiket	Debre Beat (Maria Tselam)	Engraving of camels
Tisho	Senafe (about 2 km North)	Ancient Site
Tse'azegha	20km North of Asmara	Ancient gold mine
Tsa'eda Kristian	15km North of Asmara	Ruins pottery etc.
Tsehuf Emni	Azeza (Zoba Debub)	Stone Inscription
Tekonda'e	S. of Adi Qeyeh Zoba Debub	An antique city
Terer Gemel	Between Techer and Temeza near the bank of rives Mereb Zoba Debub	Settlement ruins
Welb	Dekemhare (Dembezan)	Ancient Site
Woqerti	30km.South of Asmara	Antique city
Wokedeba	West of Asmara	Full of ancient tombs and obsidian tools
Yolwa Amba	South of Zula Semanawi Q.B	Obsidian Tools
Zala	Senafe (about 6km East)	Ancient Site
Zala-Bet meka'e	154km from Asmara towards Enda-Gaba Kokobay Zoba Debub	Abbig site probably an antiqi city
Zala-Kessad Mai	4km from Metera near the village of	Ancient ruins
Zeban Kutur	Adi-Baker Zoba Debub 30km.North of Metera Zoba Debub	Ruins, dams etc.
Zokall	South East of Sen'afe Zoba Debub	Religions buildings etc.

11.5 Appendix C. Post electrification status of some villages and towns

The referred study conducted the socio-economic impact of rural and semi-urban electrification in 2 semi-urban areas and three villages. In the **town of Hagaz**, the following observation was noted. Hagaz is a fastly developing town located 25 kms south west of the regional capital Keren or 116 kms north west of Asmara. The grid was extended to this town in 1998. Hagaz has a population of around 11,300 and 2300 households; for this number of households there were 297 meters in December 2001. Average consumption during 2000 and 2001 were respectively 472 and 496 kWh per registered meter. As accounting of electricity consumption is lumped with that of Keren, it was not easy to determine the exact number of electricity using households but around 1,000 was a fair estimate from the local administrators (note that many households could share a common meter). According to the interviewed residents including one MP, the biggest problem the customers are facing is that they have to go to Keren Office to pay their monthly bills to EEA, lining up with the Keren customers. As EEA has no representation there, there is no one to listen to potential customers requiring electricity connection and as such there have been practically no new connections since 1998. The enumerator noted that there are many commercial farms in Hagaz wanting to shift to electric pumping for irrigation but are now using diesel water pumps. Using the national figure of one employee for 141 customers, there should have been at least two (one accountant and one technician) EEA employees in principle serving Hagaz. This demands a new approach to the management of the electricity services in the town.

Dibaruwa is becoming an industrial town, as it is strategically located close enough to the market centres of Asmara (which lies 30 kms north), Mendefera (25 kms south) and Dekemhare (25 kms east). There were 2,020 households in March 2002. The total number of customers one-year after the availability of electricity was 744 of which 554 were households. Information collected on electricity consumption in the town for the year 2001 is given in Table 3.3

Table Electricity consumption by type of customers for Dibaruwa, 2001

Tariff Group	Sales, kWh	Sales, Nakfa	Service Charge, Nakfa	Number of Customers
Domestic	108,549	148,708	9410	554
Commercial	187,297	265,200	8966	163
Street Lighting	20,850	29,000	330	3
Small industry, LV	85,434	113,453	7063	22
Small industry, MV	692,800	673,302	788	2
Total	**1,094,930**	**1,229,663**	**26,557**	**744**

Source: EEA Statistics, 2001

The most significant noticeable impact of electrification in Dibaruwa town is the expansion of commercial and industrial activity. Prior to electrification there were only 21 commercial and industrial activities operating their own gensets. Since electrification the number of commercial and industrial establishments which are customers to EEA-supplied electricity has gone up to 190 firms in Dibaruwa within the first year. The average electricity consumption in kWh/year for 2001 for each tariff group in Dibaruwa is as follows: domestic 213, commercial 1,204, street lighting unit 2,180, small industrial low voltage 4,204 and medium voltage industrial 346,794. Interview with customers indicated that there is not enough electricity service provided by EEA commensurate with the ever rising demand, and some of them, especially the industrial establishments, expressed concerns of power outages. While the latter is expected to subside when the more dependable new power plant at Hirgigo

near Massawa is fully commissioned, the former concern is becoming more serious and almost common to all newly electrified areas. Although there is an EEA Office in Dibaruwa, unlike that of Hagaz, its capacity is too small to be able to serve this mushrooming industrial town. As a result of this, complaints and new applications are channelled to Mendefera, the administrative centre for the region. This state of affairs demands pertinent attention.

The **village of Azian,** electrified in 1996, is just located around 20 kms north of Asmara and has around 900 households. There are at present 108 installed kWh meters, each shared by many neighbouring households. The electrification of the village was community-driven as they paid for the costs upfront unlike in the newly electrified villages, which is project-driven. There are many households, which are not yet connected. These are household that missed the opportunity for connection in 1996 for various reasons, but have been requesting for connection since then; as in Hagaz, the people claim that the EEA is not responding to their requests. From the sampled respondents, 40% do not like the idea of sharing electricity meters as it is often a source of disagreement and would like to have their own meters. The rest would like to continue sharing as they do not have the capacity to pay for the 30 US$ electricity meter. It was noted that the income level of the village is still very low and their electricity consumption on the average is one US$ per month (just for lighting two bulbs). New income generating activities that use the availed electricity have not developed significantly. This is a good example for those who contend that electrification for its own sake, unless supplemented by other development programmes, may not bring about a dramatic change in the way of life. For instance, the access road to Azien is very rough, and this is one of the obvious drawbacks.

Another example comes from the village of **Tsada-Kristian,** located 20 km west of Asmara. Electricity reached this village in 1998, and at present 1,000 of the 1,150 households residing in the village have access to electricity, of which 73% have their own meters, while the rest share with their neighbours. The high proportion of households using their own meters tends to suggest that electricity is being used for income generation as well. In deed, many small enterprises were observed in the village during the survey. The average consumption for households and enterprises were US$ 4/month and US$ 10/month respectively. As in the other localities, complaints on power outages and lack of response to new applicants were noted. The higher consumption rate of electricity in Tsada-Kristian compared to Azien can be explained by many factors: the village has better agricultural land, has a newly asphalted road connecting it with Asmara, is a service centre for health, education and administration for the Sub- Zone.

The case from **Maéreba** shows a slightly different story. The village lies about 60 km south east of Asmara; it was connected to the grid in 1998 after the residents paid the full cost of extension upfront. Of the 500 households in the village, 375 have access to electricity sharing 99 kWh meters between them. According to the interviewees, the remaining unelectrified households have been requesting for connection either by sharing or installing own meters. In principle, sharing meters is highly advisable to reduce initial costs to poor households, and this is being promoted in the newly electrified villages. But according to the interviews EEA's representative stationed in the town of Segheneity, 15 km away from Maéreba, has refused new connections using shared meters, contrary to the policy. It was also noted here that not many income-generating activities have shown up after electrification, inspite of the fact that it lies along a major asphalted road. This is reflected in the low average consumption per meter per year of 172 kWh and 213 kWh in 2000 and 2001 respectively.

11.6 Appendix D: Ministry Directives on Rural Electrification

Directive No. EI.OO1/2001

"On Procedures of Computation of Cost of Electric Line Connection and Billing in Rural Areas and Suburbia"

Preamble:

Noting that easy access to the public to modern energy services in general and (to) electricity in particular constitutes one of the prerequisites for the success of Eritrea's endeavour for development;

Noting the opportunities rural electrification creates to the development of agriculture based small-scale manufacturing and other income-generating activities in rural communities and its resultant effect on narrowing the income and opportunity gaps between urban rural communities;

Noting the need to ensure dependable, adequate and affordable energy services; and

Heeding the importance of simultaneously ensuring sustainability of energy services and to the extent possible social equity as well as the need for cost sharing and community participation in the implementation and management of rural electrification programmes;

The Minister of Energy and Mines hereby issued the following directive:

Article 1. Short Title:

This Directive may be cited as "Directive No. 001/2001 -On Procedures of Computation of Cost of Electric Line Connection and Billing in Rural Areas and Suburbia."

Article 2. Purpose:

The purpose of this Directive is to provide standardised procedures that shall serve as a basis for computation of costs of electric line connection in rural areas and suburbia as well as to pave ways for community participation in the management of electricity supply *I* billing and collecting.

Article 3. Village Electric Co-operatives

1. Village Electric Co-operatives (VEC) are rural communities' associations whose membership is voluntary .

2. Each VEC shall have a statute defining its aims and membership procedures.

3. VEC shall assume the responsibility of allocating (sharing) among community members the cost of electric network installed to connect the village with the supply system and collecting the bills of consumed electricity from the community members and settling accounts with the electricity supplier, in this case EEA.

4. VEC shall enter into agreement with EEA for bulk power supply and settlement of accounts of electricity bills on monthly basis by charging its members.

5. VEC shall have internal regulations according to which its members share costs of connecting their community to the electric supply system as well as the total chargeable bill for consumed electricity as measured by the bulk meter placed right after the first transformer.

6. VEC may charge its running costs to its members and EEA at a rate agreed upon by all stakeholders. However EEA reserves the right to undertake the billing and collecting provided it is cheaper to do so.

7. EEA shall co-operate with the Department of Energy and or local authorities in establishing VECs.

Article 4. Cost computation of Rural Electrification

1. EEA shall cover the cost of extending the main medium-voltage trunk line from the source of supply to the vicinity of the potential consumption centre and the cost of extending the main trunk medium-voltage line to the first transformers in successive villages.

2. EEA shall consider the extension of the power supply system at its own cost to successive villages provided it is economically viable.

3. VEC shall pay the full cost of the transformer net-station, the medium voltage line after the first transformer and low voltage networks in the village.

4. Extension cost of medium-voltage trunk line from the nearest transformer to a town suburb shall be equally shared between EEA and the customer; while the cost of the transformer net-station, medium-voltage and low-voltage networks shall be fully paid by the customer and or community.

5. Extension to commercial, cottage or small industrial customer from the main trunk line to the medium voltage line transformer shall be equally shared between EEA and the customer; the costs of the transformer net-station, the low voltage (if any) shall be fully paid by the customer.

8. Costs of medium-voltage line, transformer net station and low voltage network that are needed to connect a customer with demand capacity of 250 kW and above or a total of 800,000 kWh yearly consumption shall be fully paid by the customer.

9. The purpose of installing a bulk meter is reduction of billing costs in the interest of both VEC and EEA and shall be implemented only when both parties subscribe to such an arrangement.

10. A consumer who has installed meter(s) at his premises shall be charged for the power he/she consumed at the rate officially approved for the category he is classified to and according the reading in the meter(s).

Article 5. Network Maintenance and Ownership

1. EEA shall take full responsibility to maintain the electricity supply network installed under the arrangements stated in Article 3 above.

2. EEA also reserves the full right to make modifications it deems necessary, as well as to connect new customers to the supply networks, at any point before energy meters without affecting the quality of supply to existing customers.

3. EEA shall own the electricity supply networks up to the energy meter within the premises of an individual customer and within the village irrespective of the amount of payment made by a customer to cover the connection costs.

Article 6. Cost

lude costs of material, manpower and over head as well as cost of nt deployed in executing a given work.

day of December 2001.

11.7 Appendix E: Report of a Workshop on Socio economic & environmental Impact Assessment for

The project 'Asmara Voltage Power Distribution & Rural Electrification'

In relevance to the World Bank request to prepare socio-economic & environmental impact assessment report for the projects, "Asmara Power Distribution & Rural Electrification for villages surrounding keren, Barentu, Dekemhare & Adikeyieh areas" a one-day workshop was held at the national Confederation of Eritrean Workers Conference Hall on August 1st, 2003.

The objective of the workshop was to present the findings of the Report on Environmental and Social Assessment prepared by the multidisciplinary Task Team formed whose members are from the Ministry of Energy & Mines, Department of Energy, Eritrea Electric Authority and Department of Environment.

Mr. Samuel Baire Director General of the Department of Energy opened the workshop representing the Minister of Energy & Mines, Mr. Tesfai Ghebreslassie, who was unable to attend the workshop as the meeting of the Cabinet of Ministers convened simultaneously. The Eritrea Electric Authority covered the full costs of the workshop.

Invitation to the workshop

The invitation focal groups were all sectors, directly or indirectly related to the project in its planning & implementation stage, i.e., sectors that could possibly be affected by the projects or affect the projects. About fifty participants from different urban & rural institutions were expected to participate in the workshop, and forty five experts from the major stakeholders attended the workshop actively and successfully (see list at the end).

List of Invited organizations

Organization
1. Ministry of Energy and Mines, Head office
2. Department of Energy
3. Office of Macro Policy
4. EEA Engineers (Distribution, Inspection)
5. Zoba Maekel, Dep't of Infrastructure
6. 'Biato' Rep's of six Zobas
7. Economic Departments of six Zobas
8. Dep't of Town Planning
9. Telecom Services of Eritrea
10. Dep't of Water services (Z. Maekel)
11. Dep't of Infrastructure (Z.Maekel)
12. Asso'n of Eritrean Engineers & Architects
13. Association of Electrical Contractor
14. Ministry of Land Water and Envirn't
15. Dep't of infrastructure (Public works)
16. UoA, Dep't of Archeology & Anthropology
17. UoA, Collage of Arts & Social Studies
18. Ministry of Agriculture
19. Rep. Of S/Zoba Affairs of 4 RE project areas
20. Department of Industry
21. Department of Trade
22. Chamber of Commerce
23. Association of horticultural farmers
24. Rural Enterprises
25. ECDF
26. WB
27. Italian Co-operation
28. Sida
29. Wekita consultant
30. UNDP
31. Ministry of Health
32. N.U.E.W
33. N.U.E.Y
34. National Insurance Corporation of Eritrea

Program of the Workshop

TIME	ACTIVITIES	PRESENTATION BY
8:00 - 8:30	Registration	
8:30 - 8:35	Key Note Address	H.E., Minister Tesfai G/Sellassie
8: 35 - 8:45	Background to the energy sector	Ato Samuel Baire, Director General, Energy
8:45 - 8:50	Overview of the Project & the Workshop	Dr. Semere Habtetsion, Task Team Member
8:50 - 9:25	Socio-Economic, Legal and Administrative Framework	Amanuel & Mulueberhan, Task Team Members
9:25 - 9:40	Description of the Project	Eng. Fessehatsion G/medhin Task Team Member
9:40 - 9:50 9:50 - 10:10	Baseline Environment • Physical and Biological • Socio-economics	Dr. Zemenfes Tsighe, UA Wekita Consultant
10:10 - 10:30	Tea Break	
10:30 - 10:50	Potential Environmental Impacts & Mitigation	Dr. Semere Habtetsion, Task Team Member
10:50 - 11:00	Analysis of alternatives	Eng. Fessehatsion G/medhin Task Team Member
11:00 - 11:20	Management and Monitoring Plan	Dr. Semere Habtetsion, Task Team Member
11:20 - 12:10	Discussions	All presenters
	Lunch Break	
14:00 - 14:10	Formation of Groups • Group 1 Asmara Power Distribution • Group 2 Rural electrification	
14:10 - 16:00	Group discussions	
16:00 - 16:20	Tea Break	
16:20 - 16: 40	Group presentations	
16:40 - 17:30	Recommendations and closing sessions	

Papers presented on the workshop

Ten papers were presented at the workshop by members of task team, a professor from the university of Asmara and a consultant on socio-economic aspects of the project. The themes of the presentations were mainly the results of the findings of the report. the presenters and the topic presented are listed below.

Presentation topic	Presenter	Task
Background to the energy sector	Mr. Samuel Baire	Dir. General Dep't of Energy
Overview, the Project & the Workshop	Dr. Semere Habtetsion	Task Team, Chair & Member
Socio-Economic, Legal & Administrative Framework	Amanuel Andebrhan Mulueberhan G.Yohannes	Task Team Member Task Team Member
Description of the Project	Eng. Fessehatsion G/medhin	Task Team Member
Baseline Environment ◆ Physical and Biological ◆ Socio-economics	Dr. Zemenfes Tsighe, UA Weldegebriel Tareke	University of Asmara Wekita Consultant
Potential Env'l Impacts & Mitigation	Dr. Semere Habtetsion,	Task Team Member &Chair
Analysis of alternatives	Eng. Fessehatsion G/medhin	Task Team Member
Management and Monitoring Plan	Dr. Semere Habtetsion	Task Team Member&Chair

Discussion Issues

In order to organise participants according to their interest on the two projects, it was necessary to form two groups for discussion and drafting of recommendations. Group-I was made to discuss on Asmara Power (Rehabilitation & Voltage Conversion), and Group-II on Rural Electrification.

Group-I: Asmara Power Distribution (Rehabilitation and Voltage Conversion)

Issues for Discussions & Recommendations

1. Are the negative impacts exhaustively identified? If not what can we add?

2. Lessons the project can learn from Asmara Water Distribution Project? The Massawa Electricity Rehabilitation work?

3. Are the mitigation measures proposed exhaustive, sound, and practicable?

4. Voltage conversion has already been done in some parts of Asmara. What were the reasons for some of damages occurred, some were not notified before conversion, why? What steps should be followed to fully involve the customers.

5. Should critical customers such as hospitals, University, Sensitive Goven't offices etc have standby generators.

6. The mitigation of adverse socio-economic and environmental impacts of the project requires appropriate *management and monitoring plans*. What can you add to enrich the plan?

Group -II: Rural Electrification Component

Issues for Discussions & Recommendations

1. Are the negative impacts exhaustively identified? If not what can we add?

2. What can we learn from positive and/or negative performances of the past and ongoing rural electrification projects?

3. Are the mitigation measures proposed exhaustive, sound and practicable?

4. What comments do you have on the cost sharing policy between the government and its development partners on the one hand and the benefiting communities on the other?

5. There is no doubt that the community contribution enhances the feeling of ownership and responsibility, which is beneficial in sustaining the network. What implementation problems and or good practices have you noticed from your side?

6. As per the cost sharing Directives of the Ministry stated above, only villages that have taken initiatives to raise money to cover their share shall have the benefit to be connected from the project target areas. Villages/towns from other regions of the country can also be

electrified provided the same initiative is undertaken. Payment in two instalments (effectively two harvest seasons) is permitted. Your comments on this approach are helpful.

7. The mitigation of adverse socio-economic and environmental impacts of the project requires appropriate *management and monitoring plans*. What can you add to enrich the plan presented?

RECOMMENDATIONS FORWARDED BY THE TWO GROUPS

On Asmara Power Distribution

1. **On exhaustive identification of negative impacts**

- Assessment of financial implications to possible damages on other underground utility networks/services such as water supply network, Telecom cables network is not addressed.

2. **On lessons we can learn from others**

From Asmara water supply rehabilitation program

Negative lessons

- Poor planning and approach, poor relations with stakeholders;
- Disorganized time (season) and implementation program;
- Poor information network with relevant institutions;
- Environmental problems such as debris & wreckage remnants;
- Poor awareness and safety measures;
- Frequent blockage of roads, Traffic jams;

Positive lessons

- Supply & Service is improved;
- Wastage is minimised;
- Technical skills and efficiency developed;
- Local experience on project management enhanced;

From Massawa Electricity Rehabilitation Works

Negative Lessons

- Delay of work;
- Delay in reinstating roads and side walk infrastructures;
- Poor awareness measures.

Positive lessons

- Local capacity both on technical and managerial skills developed
- Experience on project management enhanced;
- Sustainable and standardized electricity service established;
- Well organized with regard to planning.

3. **On Information on the project**

- **Advanced information system to the public and private sectors is required**
    - Public Awareness
    - Media coverage
    - Educational Materials
    - Permanent information desk

4. **On critical customers**

- Critical customers need to have standby generators mainly to avoid possible interruptions that may inflict heavy or priceless costs.

5. **On project Management**

To run this multi million and wide coverage project efficiently, accountably, & responsibly establishment of independent PMU is necessary. Experiences have shown that projects treated as auxiliary rather than primary program hardly satisfy the desired goals.

6. **On stakeholders and relevant institutions**

- Consultation & participation of stakeholders during planning & implementation stages of the project is essential.
- Development of information network and manipulation of functional softwares GIS, DOC are effective in facilitating the project task.
- Establish coordination committee among sectors most relevant to the project.

On Rural Electrification

1. **On identification of negative impacts;**

- Intensive safety measures through media coverage are necessary to enhance the awareness of the people on electrification.
- Sensitive areas such as monasteries, symmetries, shrines etc should be identified before any action is taken, especially during extension of HV lines.
- Introduction of preliminary villages' master plan is essential technically & financially for EEA, and environmentally for the villages.
- The issue of erosion during and after the electrification processes such as lining of roads and plantation of electric poles should be addressed.

2. **On positive impacts**

- Implementation of electrification program is underway according to the plan
- The horizon of consciousness of people is enhanced, due to communication accessories such as radio, TV (local & Satellite dishes) as a result of electrification
- Health concerns such as eye and lung diseases due to smoke are reduced;
- Small-scale commercial and service enterprises have started to appear and grow.
- Students particularly at a secondary level extended their study time to equalize their counterparts in the cities.
- Time for family issues are prolonged i.e. families spent longer time with their children.

- Peoples (villagers) moral is boosted and urban people attendance is increased.

3. **On mitigation measures proposed**

Careful measures should be taken not to alienate the economically nonviable villages & households;

4. **On cost sharing**

The existing cost sharing policy is meaningful and applicable

5. **On community contribution and ownership**

It is advisable that the management of electricity distributions be the responsibility of the villages, however EEA should take responsibility for repair and maintenance of high and medium voltage lines. The cost of repair for damages inflicted by a third party is the responsibility of the party in charge.

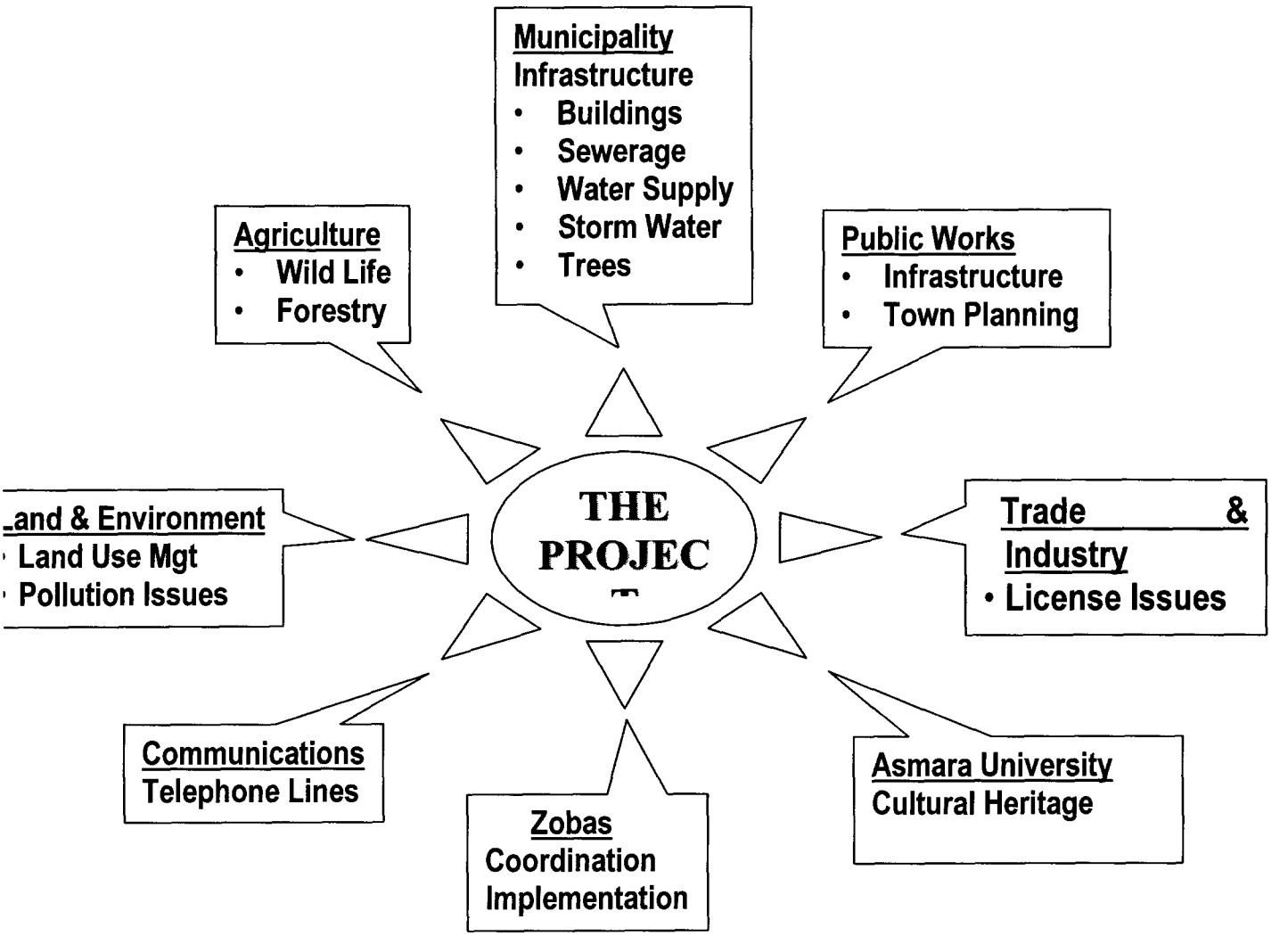
6. **On schedule of rural electrification**

First come first serve, for villages that can afford the required payment, is the most productive style of electrification. On the one hand it creates healthy competition among villages and on the other it keeps the continuity of the process of electrification as a whole.

7. **On management and monitoring**

With regard to management of reading meters, preparation & collection of bills and in-house instillations & maintenance, the EEA or the Department of Energy has to train a technician to serve as liaison or agent for EEA. Besides the technician will be responsible for in-house installations and maintenance activities. Monitoring the activities of the technician will be the task of EEA.

Overall: Infrastructural decision-making will best serve if related issues of concerned institutions are included in the planning process.



List of Participants in the Stakeholders' Workshop, August 1st, 2003.

Name	Position	Organization	Tell	e-mail/P.O.Box	Zoba
1. Ali Nur Ali	S/Parlamient	Bayto	661135	Assab	D/K/Bahri
2. Mehari Bezene	Head, Sub zoba Affairs	Zoba Admin	660840	Assab	"
3. Andres Knudby	Project Officer	UNDP	151166	5366	
4. Ghirmai Berhe	Head, City lights	Zoba Admin	124873		Makel
5. Habtu G/Amlak	Project Manager	EEA	122227		Makel
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7. Alessandro Dinicci	UN Fellow	Italian Cooperation	124563	dinicci@iboco.org6R	Maekel
8. Tsegai Andehaimanot	Div. Manager	EEA	122229		Maekel
9. Afewerki Hailu	S/Division Head	EEA	122226		Maekel
10. Tewedros Michael	Dist'n Engineer	EEA	122222		Maekel
11. Teclemariam Berhe	Expert	Dep't of Environment	126712	DOE	Meakel
12. Abrham W.Michael	General Manager	EEA	122228	EEA	Maekel
13. Michael Negash	Director	Water Res. Dep't	129636	wrd@ets.com.er	Maekel
14. Idris Suleiman		Zoba Admin.			Gash-Barka
15. Tesfai Kiflom		Min. of Energy and Mines	127944		Maekel
16. Amanuel Andebrhan	Sen. Statistician	Min. of Energy and Mines	127944		Maekel
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18. Dr. Semere Habtetsion	Director	Dept' of Energy	127944	Semereabhh@yahoo.com	Maekel
19. Tesfay G.hiwet	Member	Dept' of Energy	127944		Maekel
20. Eng. Fissehazion	Advisor to GM	EEA	121111		Maekel
21. Tsegai Mengsteab		Zoba Debub Admin			Debub
22. Tekleghirgis T.Medhin	Dep't Head	Zoba Admin	611571		Debub
23. Brhane Andemeskel	Journalist	Ministry of Information	117133		Maekel
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25. Weldegebriel Tareke	Manager	Wekita Consultancy	200489	P.O.Box – 4958	Maekel
26. Rahwa W.ghebriel	Proj. Officer	Wekita Consultancy	200489	P.O.Box – 3448	Maekel
27. Kiflay Kidane	Expert	Zoba Admin	401623	Keren	Anseba
28. Mulubrhan G.Yohannes	Expert	Min. Land, Water& Envir.	119107	MLWE	Maekel
29. Weldemichael Berhe	Gen & Transmi. Manager	EEA	121938		Maekel
30. Tekle Andemariam	Chairman	Alla Farmers Organization	121618	P.O.Box 1190	Debub
31. Hashim Beshir	Reporter	Press / MOI	117094		Maekel
32. Tekie Keleta	D.G. Infrastructure	Zoba Admin	731190		Gash-Barka
33. Mohamed Osman	Zoba Parliament (Baito)	Zoba Admin	"		"
34. Petros Tsegai	Env'ntal Eng	MOPW/Infrastructure	120442	P.O.Box 841	Maekel
35. Kibreab G.Michael	Ent. Dev't Co-ordinator	Rural Enterprise Unit	202548		Maekel
36. Eng. Sahle Mehari	Manager	Elect. Contractors Asso'n	200938	P.O.Box 7124	Maekel
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38. Dr. Zemenfes Tsige	Dean, CSS	University of Asmara	120784	Zemenfes@asmara.uoa.edu.er	Maekel
39. Rezene Russom	D/Director	National museum	119902	P.O.Box 5284	Maekel
40. Afom Tsegai	Journalist	Min of Information	201820	P.O.Box 247	Maekel
41. Abrham Berhe	Distribution Manager	EEA	127999	P.O.Box 911	Maekel
42. Tesfalem Misghina	Staff	Min. Land, Water & Environ.	124633		Maekel
43. Belainesh Seyum	Head, Int'l Relations	National Women's Assoc.	118911	P.O.Box 239	Maekel
44. Pepo Jacomino	Staff	Gash-Barka	731217		Gash-Barka
45. Andebrhan Tesfu	Staff	Zoba Debub			Debub

11.8 Appendix F: ENVIRONMENTAL AND SOCIAL SCREENING FORM

The Environmental and Social Screening Form (ESSF) has been designed to assist in the evaluation of design proposals for the Rural Electrification component. The form is designed to place information in the hands of implementers and reviewers (VA's and PPU) so that impacts and their mitigation measures, if any, can be identified and/or that requirements for further environmental analysis be determined.

The ESSF contains information that will allow reviewers to determine the characterisation of the prevailing local bio-physical and social environment with the aim to assess the potential project impacts on it. The ESSF will also identify potential socio-economic impacts that will require mitigation measures and or resettlement and compensation.

Name of Village/Town/Area to be electrified: _____

Name of Village Administrator:_____

Name of sub Zoba and Zoba : _____

Name of Approving Authority: _____

Name, job title, and contact details for the person who is responsible for filling out this form.

Name:

Job Title:

Telephone number:

Fax number:

E-Mail address:

Date:

Signature:

1. Brief Village/township Description

Please provide information on the geographical location and population profile. Also provide rough number of poles required, transformer size, optimum route, and any public or private area acquired for the project.

2. The Natural Environment

(a) Describe the land formation, topography, vegetation in/adjacent to the Project area

_____
_____

(b) Estimate and indicate where vegetation might need to be cleared

_____
_____

(c) Are there any environmentally sensitive areas or threatened species (specify below) that could be adversely affected by the project?

(i) Intact natural forests Yes_____No_____

(ii) Riverine forest Yes_____No_____

(iii) Wetlands (lakes, rivers, seasonally inundated areas) Yes_____No_____

(iv) How far is the nearest Wetlands (lakes, rivers, seasonally inundated areas)? _____km

(v) Habitats of endangered species for which protection is required under Eritrea law and/or international agreements. Yes_____No_____

(vi) Others (describe). Yes_____No_____

3. Rivers and Lakes Ecology

Is there a possibility that, due to construction and operation of the project, the river and lake ecology will be adversely affected? Attention should be paid to water quality and quantity; the nature, productivity and use of aquatic habitats, and variations of these over time.

Yes_____No_____

4. Protected areas

Does the project area (or components of the project) occur within/adjacent to any protected areas designated by government (national park, national reserve, world heritage site etc.)

Yes_____No_____

If the project is outside of, but close to, any protected area, is it likely to adversely affect the ecology within the protected area areas (e.g., interference with the migration routes of mammals or birds)

Yes_____No_____

5. Geology and Soils

Based upon visual inspection or available literature, are there areas of possible geologic or soil instability (erosion prone, landslide prone, subsidence-prone)?

Yes_____No_____

Based upon visual inspection or available literature, are there areas that have risks of large scale increase in soil salinity?

Yes_____No_____

6. Landscape/aesthetics

Is there a possibility that the project will adversely affect the aesthetic attractiveness of the local landscape?

Yes_____No_____

7. Historical, archaeological or cultural heritage site.

Based on available sources, consultation with local authorities, local knowledge and/or observations, could the project alter any historical, archaeological or cultural heritage site or require excavation near same?

Yes_____No_____

8. Resettlement and/or Land Acquisition

Will involuntary resettlement, land acquisition, or loss, denial or restriction of access to land and other economic resources be caused by project implementation?

Yes_____No_____

If "Yes" Involuntary Resettlement OP 4.12 is triggered. Please refer to RPF for appropriate mitigation measures to be taken.

9. Loss of Crops, Fruit Trees and Household Infrastructure

Will the project result in the permanent or temporary loss of crops, fruit trees and household infrastructure (such as granaries, outside toilets and kitchens, etc)?

Yes___No_____

10. Noise pollution during Construction and Operations.

Will the operating noise level exceed the allowable noise limits?

Yes___No_____

11. Solid or Liquid Wastes.

Will the project generate solid or liquid wastes?

Yes____ No___

If "Yes", does the project include a plan for their adequate collection and disposal?

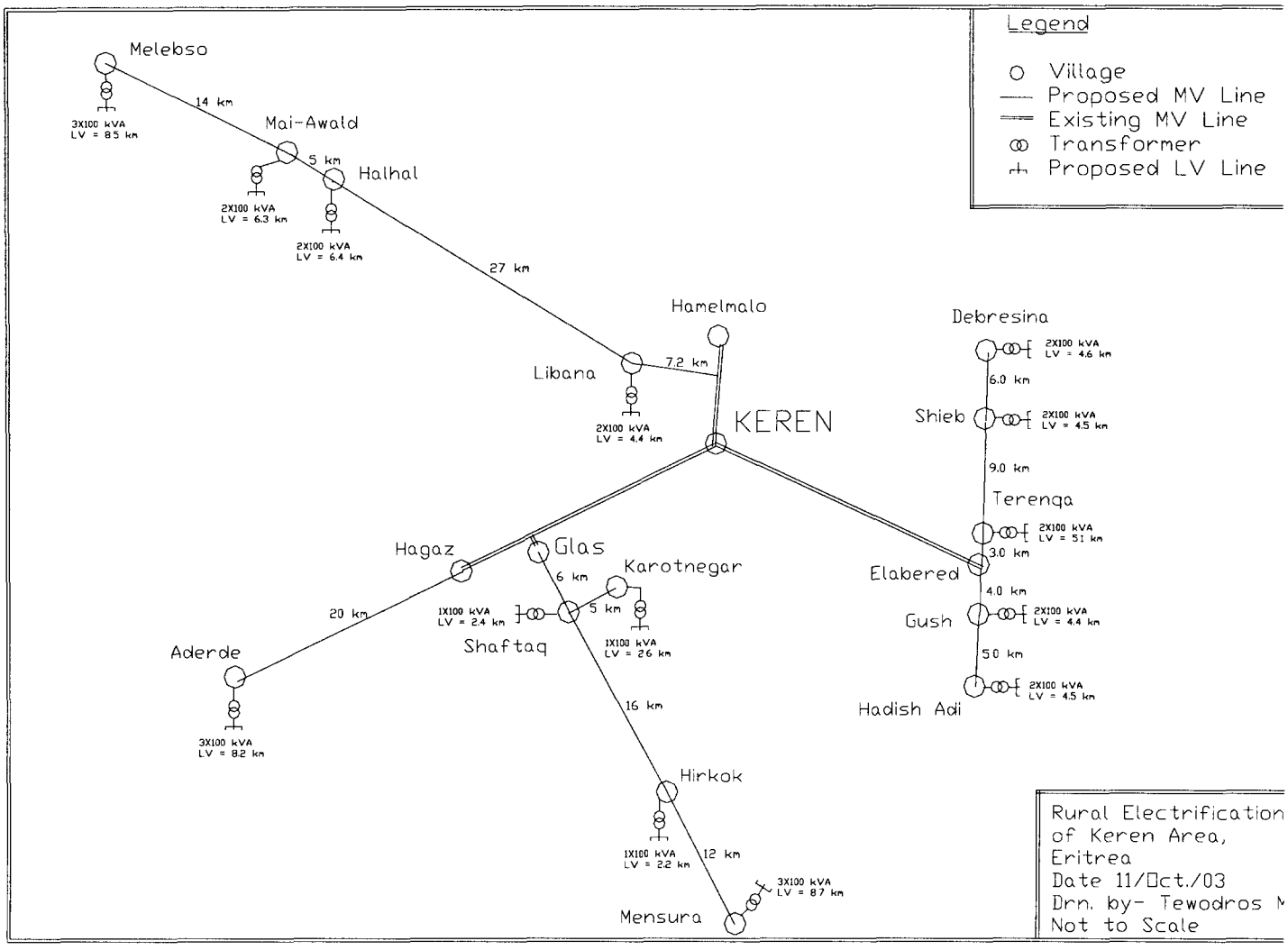
Yes____ No____

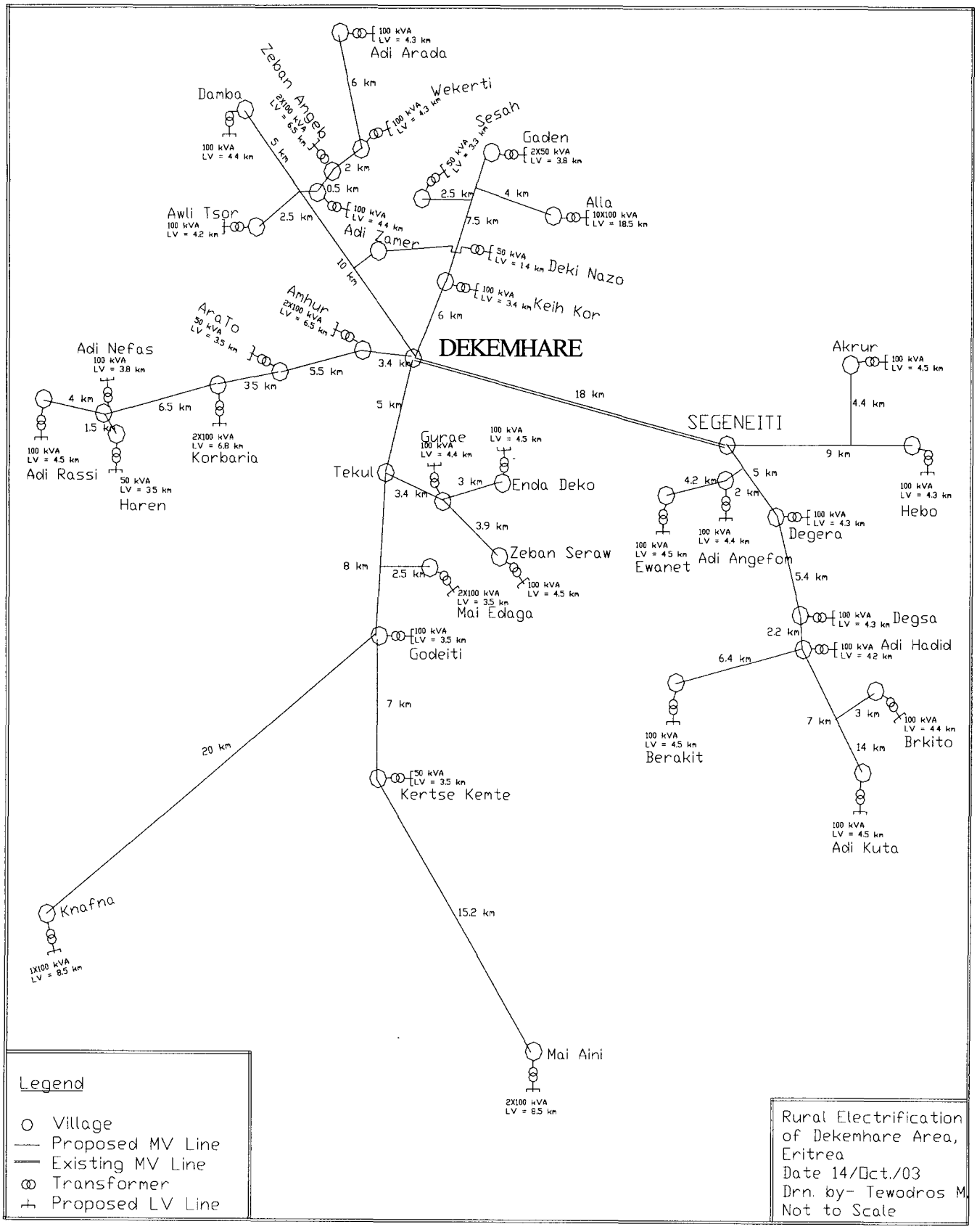
12. Public Consultation

Has public consultation and participation been sought?

Yes____ No___

If "Yes", describe briefly the measures taken to this effect.


Legend
Village
Proposed MV Line
Existing MV Line
Transformer
Proposed LV Line
Melebso
3X100 kVA
LV = 8.5 km
14 km
Mai-Awald
5 km
Halhal
2X100 kVA
LV = 6.3 km
2X100 kVA
LV = 6.4 km
27 km
Hamelmalo
7.2 km
Libana
2X100 kVA
LV = 4.4 km
KEREN
Debresina
2X100 kVA
LV = 4.6 km
6.0 km
Shieb
2X100 kVA
LV = 4.5 km
9.0 km
Terenqa
2X100 kVA
LV = 5.1 km
3.0 km
Elabered
4.0 km
Gush
2X100 kVA
LV = 4.4 km
5.0 km
Hadish Adi
2X100 kVA
LV = 4.5 km
Hagaz
Glas
6 km
Karotnegar
20 km
1X100 kVA
LV = 2.4 km
5 km
Shaftaq
1X100 kVA
LV = 2.6 km
Aderde
3X100 kVA
LV = 8.2 km
16 km
Hirkok
1X100 kVA
LV = 2.2 km
12 km
3X100 kVA
LV = 8.7 km
Mensura
Rural Electrification
of Keren Area,
Eritrea
Date 11/Oct./03
Drn. by- Tewodros M
Not to Scale


DEKEMHARE
Adi Arada
100 kVA
LV = 4.3 km
6 km
Wekerti
100 kVA
LV = 4.3 km
Zeban Angeb
2X100 kVA
LV = 6.5 km
5 km
Damba
100 kVA
LV = 4.4 km
2 km
0.5 km
Awli Tsor
100 kVA
LV = 4.2 km
2.5 km
100 kVA
LV = 4.4 km
Adi Zamer
10 km
Sesah
50 kVA
LV = 3.3 km
Gaden
2X50 kVA
LV = 3.8 km
2.5 km
4 km
Alla
10X100 kVA
LV = 18.5 km
7.5 km
50 kVA
LV = 1.4 km
Deki Nazo
100 kVA
LV = 3.4 km
Keih Kor
6 km
Amhur
2X100 kVA
LV = 6.5 km
AraTo
50 kVA
LV = 3.5 km
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Adi Nefas
100 kVA
LV = 3.8 km
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4 km
6.5 km
1.5 km
100 kVA
LV = 4.5 km
Adi Rassi
50 kVA
LV = 3.5 km
Haren
2X100 kVA
LV = 6.8 km
Korbaria
5 km
18 km
Akrur
100 kVA
LV = 4.5 km
4.4 km
SEGENEITI
9 km
100 kVA
LV = 4.3 km
Hebo
Gurae
100 kVA
LV = 4.4 km
100 kVA
LV = 4.5 km
Tekul
3 km
Enda Deko
3.4 km
3.9 km
Zeban Seraw
100 kVA
LV = 4.5 km
8 km
2.5 km
2X100 kVA
LV = 3.5 km
Mai Edaga
4.2 km
5 km
2 km
100 kVA
LV = 4.5 km
Ewanet
100 kVA
LV = 4.4 km
Adi Angefom
100 kVA
LV = 4.3 km
Degera
5.4 km
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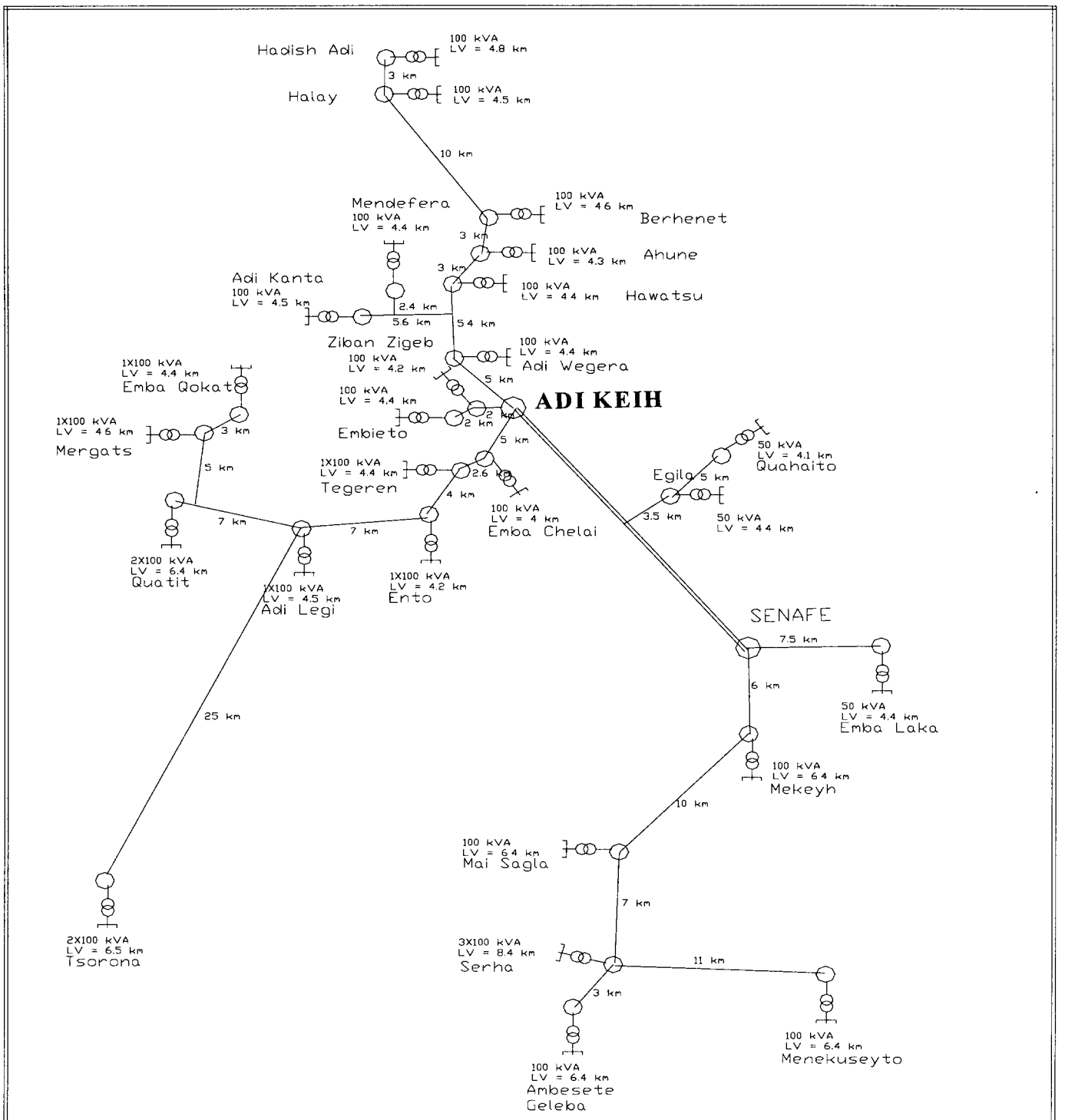
LV = 4.3 km
Degsa
2.2 km
100 kVA
LV = 4.2 km
Adi Hadid
6.4 km
100 kVA
LV = 4.5 km
Berakit
7 km
3 km
100 kVA
LV = 4.4 km
Brkito
14 km
100 kVA
LV = 4.5 km
Adi Kuta
100 kVA
LV = 3.5 km
Godeiti
7 km
20 km
50 kVA
LV = 3.5 km
Kertse Kemte
15.2 km
Knafna
1X100 kVA
LV = 8.5 km
Mai Aini
2X100 kVA
LV = 8.5 km
Legend
Village
Proposed MV Line
Existing MV Line
Transformer
Proposed LV Line
Rural Electrification of Dekemhare Area, Eritrea
Date 14/Oct./03
Drn. by- Tewodros M.
Not to Scale



Rural Electrification of Adi Keih Area,
Eritrea
Date 11/Oct./03 Drn. by- Tewodros M.
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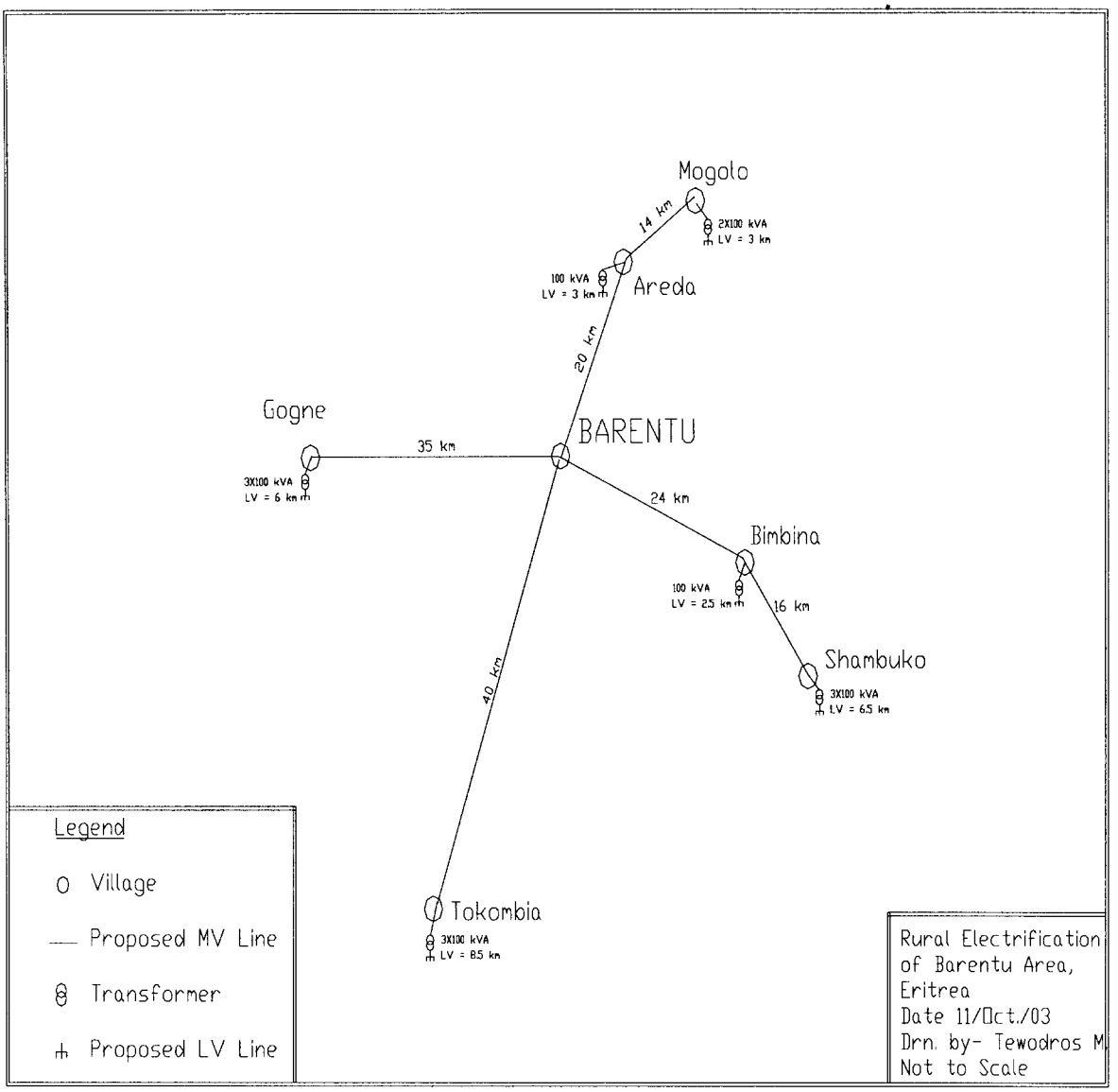
Legend

- Village
- Proposed MV Line
- Existing MV Line
- Transformer
- Proposed LV Line


Mogolo
14 km
2X100 kVA
LV = 3 km
100 kVA
LV = 3 km
Areda
20 km
Gogne
35 km
BARENTU
3X100 kVA
LV = 6 km
24 km
Bimbina
100 kVA
LV = 2.5 km
16 km
Shambuko
3X100 kVA
LV = 6.5 km
40 km
Tokombia
3X100 kVA
LV = 8.5 km
Legend
Village
Proposed MV Line
Transformer
Proposed LV Line
Rural Electrification
of Barentu Area,
Eritrea
Date 11/Oct./03
Drn. by- Tewodros M
Not to Scale