

UNITED NATIONS DEVELOPMENT PROGRAMME
GLOBAL ENVIRONMENT FACILITY

A PROPOSAL FOR PDF BLOCK B GRANT

Country : Eritrea

Focal Area : Climate Change

Project Title : Wind Energy Applications in Coastal Regions of Eritrea

Requesting Agency : UNDP

National Executing Agency : Ministry of Energy, Mines & Water Resources
Department of Energy

Block : PDF Block B

Amount of PDF requested : \$315,900

Co-Financing : \$ 55,000 (Government of Eritrea, in kind)

Block "A" Grant : No (\$25,000 Preparatory costs met by the Eritrean Government)

GEF Eligibility : UNFCCC accessed on 24 April 1995

Duration : 15 months

Background and Objectives

1. Eritrea, an arid and semi-arid country located on the Horn of Africa, obtained its independence on 24 May 1991 after a protracted war which lasted over three decades. It has a land area of about 122,000 square km with about 12,000 sq. km being categorized as cropland and 49,000 as grazing land. With an estimated population of about 3 million, the country has per capita income of between US\$130 and \$150.
2. As in many other developing nations, over 80% of the total energy demand and over 96% of the household energy needs are met from biomass (fuelwood, charcoal, animal wastes and crop residue). This huge consumption of biomass, estimated to be 2.2 million tonnes or about 1 tonne per capita in 1993, has directly contributed to a drastic loss in vegetative cover and to the overall degradation of Eritrea's terrestrial environment. The unsustainable and unmanaged use of biomass coupled with less than 10% efficiency of traditional cookstoves is implicated in greenhouse gas emissions as well as eye and respiratory diseases caused by smoke and particulate matter from wood burning.
3. The supply and efficiency of commercial energy (mainly electricity and oil products) was severely weakened before independence. The war damages and deliberate neglect of maintenance and repair services has caused significant reduction in energy transformation facilities like generators and the refinery at Assab. The per-capita consumption of commercial energy is merely around 0.2 tones oil equivalent (toe) as opposed to 0.7 toe average for the world's developing countries.

Crude oil is imported, refined in Assab and distributed to Eritrea and Ethiopia on a quota basis.

4. The electricity supply which now accounts for 3% of the total energy consumption is limited to the capital and other cities. Essentially the whole rural population, comprising about 80% of the total, is still living without electricity. The Eritrean Electric Authority (EEA) operates two systems, the Self Contained System (SCS) and the Inter Connected System (ICS). The ICS serves Asmara, Massawa and the towns in-between (see table below).

<u>System</u>	<u>Installed Capacity</u>	<u>Firm Capacity</u>
ICS	64.7 MW	45.4 MW
SCS	18.2 MW	14.8 MW

5. Of the ICS generators which are all consuming either diesel or fuel oil, 30.6 MW capacity or 47.4% of the existing total were commissioned after independence. The corresponding figures for the SCS are 10.6 MW or 58%. The efficiency of electricity generation is estimated to be 36% for the ICS and 32.2 for the SCS. As the Government has given top priority to the power sector, it has approved the establishment of an 84 MW power plant (heavy fuel oil fired). Completion of this project is expected in 1998 and the site is in Hirgigo near Massawa.
6. The share of non-biomass renewable technologies is still small in terms of total power output. The installed photovoltaic systems have a capacity of about 100 KW. This capacity is concentrated in high-value use such as schools, clinics and water systems in isolated areas.
7. The issue of renewable energy development and promotion is a priority area for the Government of Eritrea. To date, has been no energy plan developed and little energy-sector activity other than for oil exploration activities.
8. Although Eritrea is poorly endowed with proven hydrocarbon deposits and hydroelectric potential, it is believed to be endowed with great potential for geothermal and wind energy applications.
9. Along the Red Sea the Eritrean Electric Authority (EEA) is running several self contained grid-system (SCS). The largest one is the SCS in Assab with a total installed power capacity of 3.8 MW_{el}. One machine has a capacity of 1.4 MW_{el}, furthermore six other machines with a capacity of 400 kW_{el} each are under operation. Additionally there are two power stations connected to the SCS in Assab: One is the 16 MW_{el} which is in the hand of the port authority.

The other systems are quite small. However they all have in common that the electricity is generated by means of diesel fuel.

Thus, at present the electricity generation in all these systems is dominated by the use of diesel fuel. However, the geographical position and the meteorological conditions especially in the southern coastal areas of Eritrea indicate very favorable conditions for applying wind energy technology. For example the first wind velocity measurements in Assab show that this area is one of the best suitable sites for wind to electricity conversion in the world with between 1968 and 1978 annual mean wind velocities of more than 9 m/s (at 10 m above ground) being measured at certain locations near Assab. Similar results were presented in a paper by Woldegiorgis in 1988 ("Wind energy Survey in Ethiopia", in: The Solar and Wind Technology, Volume 5, Number 4, 1988.) It can be anticipated that the coastal areas north of Assab are characterized by similar wind velocities.

The measured data mentioned above have been collected and analyzed by the Ministry of Energy, Mines and Water Resources of Eritrea. First rough estimations show that this wind velocities are high enough to generate electricity out of wind energy at least at the same or with lower cost as diesel based generation of electricity. Because of the promising wind velocities on the one hand and the opportunity to substitute electricity out of old, low efficient diesel generators on the other hand, a feasibility study should investigate the technical and economical viability of a wind converter integration in the self containing grid systems in the coastal areas of southern Eritrea as soon as possible.

10. Expected Benefits of The Proposed Wind Energy Applications

The following benefits are expected to be achieved with the implementation of the proposed project:

- a saving of fossil fuels,
- a lowering of the dependence on oil imports
- a (probable) lowering of the overall electricity generation costs in the self contained systems.
- the provision of clean water supply by wind pumps to the community

11. The main objective of this project is to assist the Government of Eritrea in the formulation of a comprehensive national programme to remove barriers to the widespread adoption of wind energy technology. Specifically, the project will:

- (a) estimate the technical and economic potential of wind energy along the Red Sea in the south of Eritrea;
- (b) identify barriers which prevent the realization of expanded application of wind energy in Eritrea and to analyze the challenges posed by increased reliance on intermittent power sources;
- (c) prepare a conceptual design of the windfarm integration into the self-contained grid system of Assab and the other smaller self-contained systems along the coast;
- (d) estimate the electricity generation costs of wind-energy to be fed into the Assab grid, as well as in the self-contained systems, and to carry out a cost-benefit analysis;
- (e) use data logging equipment to develop a reliable baseline of wind speed data at the best site sufficient to provide the foundation for initial pilot windfarm;

- (f) develop a plan for systematic measurement of wind velocity at the most promising additional sites for future wind-farm deployment; and
- (g) prepare a project brief and a project document to undertake a project designed to remove barriers to wind-electric generation in Eritrea and to promote its rapid deployment.

12. **Description of Proposed PDF Activities**

The PDF Block 'B' grant will be used to undertake the following activities and tasks:

- (a) Assessment of the technical, economic and environmental feasibility of promising wind energy technologies.
- (b) Conduct a detailed review of the barriers to the widespread adoption of wind energy in Eritrea and design a programme to overcome them.
- (c) Prepare a feasibility study for the connection of windfarms to the self-contained grid systems in the coastal areas of Southern Eritrea.
- (d) *Analysis of wind resource*
 - preselection of several locations where wind measurements have to be undertaken;
 - installation of wind measuring instruments and measurements of wind velocity and wind directions during a period of at least one year at the most promising of those sites;
 - analysis of wind measurement data and calculation of long-term annual wind velocities by comparing the one year measurements with available long term data; and
 - calculation of the regional annual wind energy potential and identification of the locations with the best wind conditions for future wind-farm developments.
- (e) *Analysis of existing power system with regard to wind power integration*

To carry out technical and economic analysis of the installed power generation and the existing grid system in Assab and in the smaller self-contained systems along the coast in the area under investigation. This analysis shall especially consider possibilities of wind power integration into the grid and the potential for stand-alone, small-scale wind generators;

- (g) Wind power integration strategy
 - selection of favorable sites for possible installation of wind generating with respect to the wind velocities and electricity grids;
 - determination of the wind power capacity with respect to the number of wind turbines that can be operated grid-connected considering wind resource, electricity grid and present and future energy demand; propose optimal windfarm arrangements for this wind power capacity and determination of the yearly electricity output of the wind turbines;
 - definition of several wind integration strategies; technical and economical analysis of the strategies.
 - analysis of other potential uses of wind energy like for water pumping, grinding mill, and in small-scale stand-alone systems.
- (h) *Analysis of Environmental impacts*
 - determination of the reduction of SO₂, NO, dust and greenhouse gas emissions for the defined wind integration strategies; both direct and indirect emissions shall be taken into account;
 - qualitative analysis of other environmental impacts (e.g. area consumption).
- (i) *Comparison of the different strategies*
 - comparison of the economic characteristics.
 - comparison of the environmental impacts
 - consultation with key national stakeholders
 - cost-Benefit-Analysis considering
 - overall economic benefits,
 - social benefits and
 - environmental benefits.

Since many of the environmental and social benefits are not monetarily quantifiable, for those at least a qualitative analysis should be carried out.

Outputs

- (a) GEF project brief, including incremental cost analysis and a plan for monitoring and evaluating the programmatic benefits of the project;

- (b) A detailed capacity building plan for strengthening Eritrea's technical and institutional capabilities for wind energy development;.
- (c) A Donor Consortium willing to provide funding for the proposed activities and for reviewing the range of alternative financing sources; and
- (d) A draft project document for the proposed project.

14. **Justification for Funding**

The government of Eritrea acceded to the United Nations Framework Convention on Climate Change on 24 April 1995. The proposed project is consistent with the GEF Climate Change Operational Programme 6 "Promoting the adoption of renewable energy by removing barriers and reducing implementation costs".

15. **National Level Support**

The proposed project is fully consistent with the Government of Eritrea's national development policy in which the development of renewable energy is a top priority.

16. **Budget**

The total cost of the PDF activities is calculated to be \$370,900, of which the GEF is being requested to provide \$315,900 which would be used for the following activities:

ACTIVITIES	GEF	GOE	TOTAL
1. National Project Consultants	\$ 37,000	-----	\$ 37,500
2. International Experts/Consultants	\$ 80,000	-----	\$ 80,000
3. Installation/Operation of Wind Speed Monitoring Facility at most promising site (Assab)	\$120,000	\$ 30,000	\$150,000
4. Training, consultation and capacity building	\$ 30,000	-----	\$ 30,000
5. Travel and Secretariat Support	\$ 25,000	\$ 25,000	\$ 50,000
Sub-total	\$292,500	\$ 55,000	\$347,500
Project Support Services (8%)	\$ 23,400		\$ 23,400
TOTAL	\$315,900	\$ 55,000	\$370,900

Expected Date of Completion

The PDF activities are expected to be concluded within a period of eighteen (18) months.

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دولة ارتريا

وزارة الطاقة والتعدين والثروة المائية

The State of Eritrea
Ministry of Energy, Mines and Water Resources

UNDP - RBA - GEF
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التاريخ 21/03/96
Date
المرجع ED/11/268/96
Ref.

Att. Dr Ademola Salau

Subject: Application for financing a feasibility study for Wind Energy Applications in Coastal Regions of Eritrea.

Dear Dr. Salau,

The use of renewable energies is one main instrument to protect the global environment, to reduce greenhouse gas emissions and to contribute to an environmentally sound and sustainable development. Within the various renewable energy technologies, especially the electricity generation out of wind energy has shown a remarkable development during the last decade leading to the possibility of producing electric energy out of wind at favourable places with comparable low costs.

The newly independent State of Eritrea is actually in the process of renovating and expanding its war - damaged electric power generation, transmission and distribution system and is aiming at extending the use of renewable energy technologies wherever favourable conditions for their application are available.

Such favourable conditions for wind energy applications exists especially the region around Assab. The southern Red Sea Coastal region offers very prospective wind resources and, at the same time, the possibility to reduce fuel oil consumption and the related emissions in the existing diesel generators from which electricity is generated at present. Moreover, as this region is one of the least developed parts of Eritrea where pure water and electricity supply are quite limited and inadequate, wind - diesel combination or stand alone wind electric with storage could be an ideal solution for the region.

With this background the Ministry of Energy, Mines and Water Resources of Eritrea applies for a financing of a feasibility study under the framework of the Global Environmental Facility (GEF). The title of the feasibility study is proposed to be:

Feasibility Study for the Installation and Operation of Wind Energy Applications in Coastal Regions of Southern Eritrea.

The terms of reference for such a feasibility study have already been prepared by the Department of Energy and are enclosed to this letter. It is assumed that a total amount of US\$ 300,000 - will be necessary for the total feasibility study.

We strongly believe that this project meets all important criteria which are necessary for financing under the GEF and that it will contribute to all of the major goals of the GEF. We are therefore in the expectation of your positive answer as soon as possible.

Yours sincerely,

Samuel Baire
Director General
Department of Energy

