United Nations Development Programme
Global Environment Facility

Project Document

PIMS number: 179
Project title: Wind Energy Application in Eritrea
Project number: ERI/03/G
Country: Eritrea
GEF focal area: Climate change
GEF programming framework: OP#6, promoting the adoption of renewable energy by removing barriers and reducing implementation costs
Eligibility: Eritrea ratified the UNFCCC on 24th of April 1995
Duration: 3 years
Estimated start date: January 2004
Estimated end date: January 2007
Implementing Agency: UNDP
Executing Agency: Department of Energy, Ministry of Energy and Mines, Government of Eritrea

Brief Description: The project aims at transforming the market for wind energy applications in Eritrea. Key components are the installation and operation of a small wind park (750 kW) connected to the grid as well as eight decentralised wind stand-alone and wind-hybrid systems in rural villages. Alongside, the project will strengthen the country's capacity in terms of personnel, know-how, governmental institutions/authorities, and private companies with regard to wind energy utilisation. Small scale decentralised wind stand-alone and wind hybrid systems will promote sustainable socio-economic development as well as improve the quality of life for the rural population of Eritrea's wind rich regions. Furthermore, the project will reduce greenhouse gas emissions stemming from existing diesel generating facilities in Eritrea by supplying the demand for electric energy with electricity cleanly produced from renewable sources. The project also ensures that the use of wind energy will be considered in future national electrification plans, particularly in wind favourable regions, by demonstrating it as a cost-effective electricity generation technology, which can be replicated throughout the country.

Budget Summary (US$):

Costs and Financing (in US Dollar)		
GEF	Project:	1,950,561
	PDF B:	315,900
	Subtotal GEF:	2,266,461
Co-financing	Government (in cash)	2,000,000
(Parallel)	Government (in kind):	40,000
	SIDA:	837,000*
	UNDP TRAC:	26,500*
	Danida:	91,500*
TOTAL PROJECT FINANCING:		**5,261, 461**

*Please note that these funds have been spent already during and after the PDF B phase. Please refer to section A3 and C1 for further explanation.

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Date: ……..

For the Ministry of National Development (MoND): ……..

Date: ……..

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Abbreviations

DoE- Department of Energy
EEA - Eritrean Electricity Authority
ERTC - Energy Research and Training Centre
GEF - Global Environment Facility
GIS - Geographic Information System
GoE- Government of Eritrea
ICS - InterConnected System
kWh - Kilo Watt Hours
MoEM - Ministry of Energy and Mines
MoLG - Ministry of Local Government
MoND - Ministry of National Development
MW- Mega Watt
O&M - Operation and Maintenance
PCE- Petroleum Corporation of Eritrea
PMU - Project Management Unit
PPA- Power Purchasing Agreement
PV - PhotoVoltaic
SIDA - Swedish International Development Assistance
SCS- Self Contained Systems
UNFCCC - United Nations Framework Convention on Climate Change
WIS- Wind Information System

A. Context

A1. Description of sector

Eritrea is a new country located in the Horn of Africa, which joined the community of nations after the UN supervised referendum in 1993. Its total land area is 124,320 km^2 and its population was 3.2 million in 1999 of which around 80% live in rural areas and 20% in urban and semi-urban settlements. Eritrea was on the path to strong economic and social development until this process was stopped by renewed conflict with Ethiopia during 1999-2000. However, the previous economic and social development is expected to continue after the border dispute with Ethiopia is settled. Despite this economic development, Eritrea is still one of the least developed countries of the world, facing acute shortages of modern energy especially in the rural areas. The comprehensive energy survey of 1998 by the Department of Energy (DoE) estimated the total final energy consumption to be around 619,580 toe of which 68% was accounted by the household sector, 16% by the commercial/public sector, 13% by transport and 3% by industry. The sources of energy were 66,3 % biomass based (fuel-wood, dung, charcoal, agriresidue), 31,6 % oil products and 2.1 electricity, which is all generated by thermal means using oil products. It is also noted that more than 95% of the rural population and 20% of the urban residents do not have access to electricity. The survey also shows an extremely low per capita electricity consumption of only 48 kWh per capita in 1997, and the DoE calculated 54 kWh of electricity consumption per capita in 2001. The fact that about 82 % of the generated electric power is consumed in the areas supplied by the Asmara-Massawa Inter-Connected System (ICS) and the balance of 18 % in the rest of the country shows an unequal distribution of the power supply system in the country mainly due to the concentration of commercial and industrial activities around the capital. At present electricity is supplied to about 20 % of the population and is almost exclusively limited to the urban areas.

Eritrea faces major constraints to its efforts to meet the growing national demand for commercial energy. These include inefficient energy production, distribution and consumption, lack of awareness of the need for energy conservation, and a lack of financial and technical capability. In order to facilitate the economic development of Eritrea, further development of the electricity sector is necessary. Partly, this has been achieved with the commissioning of the 88 MW Hirgigo Power Plant in March 2003. However, future developments cannot be based only on the utilisation of fossil energy sources because it scarce hard currency must be used to import oil products.

At present, the energy consumption pattern in Eritrea is clearly unsustainable. Biomass energy, used mainly for cooking purposes and covering basic living needs, contributes to around 80 % of the country's total energy consumption. Biomass is burnt in a very inefficient manner in traditional stoves, and its use is contributing to deforestation, which leads to land degradation and also has a negative impact on the global greenhouse gas emissions balance. Currently, electricity is generated only by diesel generation sets that burn fossil fuels, diesel and fuel oil, which also increase greenhouse gas emissions.

A2. Host country strategy

It is a desire of the Government of Eritrea (GoE) to change this situation through development of sustainable energy supplies. Apart from its national goals, the GoE is considerate of global environmental concerns and the resulting global climate protection goals, as indicated by its ratification of the UN Framework Convention on Climate Change (UNFCCC) on 24.04.1995. Another indicator is the continuous will of the GoE to finance the Energy Research and Training Centre (ERTC) under the DoE, and its activities regarding adaptation and implementation of renewable energy technologies and implementation of comprehensive capacity building activities in this area.

In order to improve upon the current situation the Eritrean government has formulated a National Energy Strategy, with the multiple purposes of:

- Promoting economically and environmentally sound energy sector development through the use of appropriate energy production technology and energy conservation and usage optimisation.
- Implementing a policy of appropriate energy pricing structures that avoids all types of subsidies.
- Diversifying energy sources in order to minimise the country's dependence on dwindling biomass energy resources and imported oil, by promoting private capital participation in hydrocarbon exploration and developing renewable energy resources.
- Modernising and expanding the country's power generation and distribution system and creating an environment for private sector participation in energy development and energy markets.
- Developing capacity through training and establishing the necessary institutional and legal frameworks that can competently manage the sector.

A3. Prior and ongoing assistance

Initiatives have already begun to meet portions of Eritrea's national energy objectives. The following activities are worth noting:

(1) The ERTC has started with the measurement of solar radiation and wind speeds resulting in the preparation of solar energy maps and wind resource analysis since 1996.

(2) Several studies regarding the improvement of cooking stoves in Eritrea have been carried out in recent years at the ERTC. At this moment, the production and implementation of new improved cooking stove version is occurring all over the country.

(3) The ERTC has implemented a programme for providing schools, village water pumps and hospitals in rural areas with small PV systems. A firm capacity of 500 kWp has been achieved to date.

(4) A study, carried out at the DoE in 1998-1999, has analysed the waste potential in Asmara with regard to its utilisation for energy purposes.

(5) In the PDF-B activity of this project, the wind potential in the south of Eritrea was investigated.

(6) A Swedish financed project, started in 1998 and finished in 2002, analysed wind and solar resources in Eritrea with the installation of 25 measurement stations throughout the country. Apart from the provision of software and training, the project also included assistance to revise the legal and regulatory framework for the energy sector.

(7) In order to review and actualise the outputs of the PDF-B activity, as well as to include the recent developments for promoting the use of renewable energies in Eritrea, UNDP-Eritrea organised a reconnaissance mission in March 2003. The main objective of this mission was to review, update and prepare the draft for the present project proposal.

A4. Institutional framework

The Ministry of Energy and Mines (MoEM) has the overall Government mandate to promote and guide the development of the energy and mining sectors. DoE is responsible for drafting policies, strategies and action programs for the energy sector. The DoE has three Divisions, namely, Energy Management & Development, Energy Research & Training that also manages the ERTC, and Hydrocarbon Exploration and Promotion. The MoEM has established the ERTC to promote Research and Development principally on renewable energy resources and technologies for energy conservation. In 2002, with the financial assistance from SIDA of Sweden, the MoEM was assisted in setting and implementing appropriate energy laws, regulations and standards, thus creating a conducive legal framework for the sector.

The Eritrean Electric Authority (EEA) and the Petroleum Corporation of Eritrea (PCE) are public utilities having administrative and financial autonomies. The activities of both utilities are controlled and overviewed by a Board of Directors whose chairman is the Ministry of Energy and Mines. The

main tasks of EEA include operating the electricity generation, transmission, distribution systems and collecting tariffs. In Eritrea all electricity is generated by thermal power stations that use imported oil. Most of the power utilities in the country are owned and operated by the EEA that operates two system types, i.e. the Inter-Connected System (ICS) and the Self - Contained Systems (SCSs). The total firm capacity of both power systems is around 156 MW. The firm capacity of the SCSs totals 15 MW the largest of which is that of Assab (8 MW). From the total electricity generation of 199 GWh in 2000, 80% was consumed in the areas covered by the ICS and 20% in the SCS; of this total electricity consumption, 44.6 % was accounted by industry, 36.7 % by the household sector and 18.7 % by the commercial and other sectors. The main tasks of the PCE are importing crude and refined petroleum products and ensuring the supply of refined products to the local market. Private oil companies share the distribution market.

B. Project justification

B1. Problem to be addressed and the present situation

An important goal of Eritrea's national energy policy is creating an adequate energy supply sufficient to meet the needs of the entire country. This means that the electricity sector needs to expand the ICS and provide other areas of the country, especially those having prospering economic activities, with electric energy (e.g. Assab). Purely rural areas will potentially have access to at least a minimum supply of electric energy. With financial support from SIDA and the World Bank (grant and soft loan respectively), the Ministry of Energy and Mines has embarked on extending the ICS grid to many of the villages around large cities, major roads, and transmission and distribution lines. Around 14,100 households have benefited from the completed electrification programme 1999-2001, while during the years 2002-2004 more than 46,200 households from villages and rural towns are expected to be electrified. The electricity production demonstration sites for the present project lie at distances ranging from 35 to 100 km from the grid system, and wind water pumping demonstration sites lie at both on- and off-grid locations.

While wind energy applications are non-existent in Eritrea, some PhotoVoltaic (PV) systems have already been implemented during the last years. The ERTC has already built up a level of expertise in this field and is actually disseminating PV systems and the respective know-how and technical expertise in selected rural communities. The level of technical know-how of PV technology is therefore presently higher than it is for wind energy technology.

However, preliminary analysis has shown that there is significant wind energy potential in southern Eritrea. A PDF-B activity was implemented between January 1998 to May 1999 in order to investigate this assumption and determine whether the extensive utilisation of wind energy technology in this region could accelerate both rural electrification in this region and expansion of the grid system of Assab, the major city in southern Eritrea. The wind measurements from the PDF-B activity supported the assumption that there is large wind resource potential in the region. Indications that there are also locations with favourable wind conditions in the middle and northern regions of Eritrea were verified by the Swedish financed project in 1998-2002.

However, several barriers, described below, still hinder progress toward widespread adoption of wind energy technology in Eritrea this project aims at removing these barriers and demonstrate the technical and economical feasibility of exploiting wind energy in Eritrea. With barriers removed, the government and the private sector would be able to develop the electricity sector in a sustainable way on their own after the pilot phase. Pilot projects in selected villages and existing grid(s) will set the stage for the implementation of wind energy technologies in other places of Eritrea.

Presently neither any grid-connected wind parks nor off-grid wind-diesel hybrid systems exist in Eritrea. Both in the existing grids and in off-grid systems, electricity is supplied solely by means of power generation sets, fired with diesel and fuel oil. The good wind regimes found in many places in Eritrea makes it possible to save at least a part of the diesel costs by means of feeding wind electricity in the grid. Other possibilities to reduce the use of fossil fuel for electricity generation in Eritrea are mainly the replacement of the diesel gen-sets with more efficient conventional power generation technologies or, to a certain extent, the use of geothermal energy, but it is reasonable to assume that wind electricity generation is the option which could be realised within the shortest time frame and which would be, at wind favourable sites, a least-cost option.

B2a. Awareness / experience barriers

Barriers pertaining to the lack of experience with wind energy increase the transaction costs for the initial development of wind energy systems. These include:

(i) no existing example of grid-connected wind parks in Eritrea,
(ii) no existing example of off-grid wind-diesel hybrid systems in Eritrea (the combination of (i) and (ii) means that there is no tangible example for potential investors or developers, for the economical and technical feasibility of wind energy in Eritrea),
(iii) no experience inside EEA regarding the installation and the operation of wind turbines; this is of particular importance since EEA is the only company being able to carry out the task of operation and maintenance of larger electricity generation systems in Eritrea. No other company presently exists that possesses a similar amount of technicians or engineers for such kind of tasks,
(iv) lack of experience inside the Eritrean private sector with regard to the private business opportunities wind park projects offer
(v) lack of adequate model contracts, on the basis of which private developers and EEA can negotiate Power Purchasing Agreements (PPAs) and other necessary contracts for such kind of projects,
(vi) a very low level of awareness in the general population about wind energy technologies and the potential they offer.

B2b. Capacity / institutional barriers

Even though the natural resources of wind energy are favourable, the technology for the utilisation of wind energy is not established in Eritrea. The reasons are several general barriers with regard to:

(i) insufficient technical know-how and the non-availability of adequate trained manpower resources in the private sector, in the governmental authorities dealing with wind energy, and in the Eritrean Electric Authority,
(ii) the lack of clearly described procedures and responsibilities for the initiation, the development and the implementation of rural renewable energy projects, and
(iii) the lack of developed and implemented financing mechanisms which take into account the special features of renewable energy technologies,
(iv) the lack of tested model contracts such as PPAs, wheeling agreements etc.

B2c. Technical barriers

The existing grids are laid out for the operation with diesel generation sets only. They have to be optimised with regard to technical reliability and operation strategy before a wind park can be integrated. For the grid of Assab, a study has investigated the possibilities to integrate a wind park. Technical barriers are here mainly:

(i) the high failure possibility of individual grid segments and the resulting part-time loss of electricity demand, and
(ii) the lack of a suitable grid connection possibility at the identified wind park location.

If these barriers are not removed wind energy can not be used cost-effectively and therefore the electricity cannot be sold to the utility.

B3. Expected end-of-project situation

At the end of the project it is expected that the existing barriers for a continued and sustainable development of wind energy will have been removed. Future utilisation of Eritrea's favourable wind regime will bring direct benefits to Eritrea in the form of electricity production that is relatively cheaper compared to traditional fossil fuel production. This means that electrification of rural areas can expand faster and be more economically attractive. Rapid rural electrification will in turn stimulate enterprise development; improve living conditions and service provision by schools and health facilities etc. Productive uses of wind energy, such as mechanical water pumping, will also have been stimulated. Of Eritrea's 2500 villages, the 316 with a favourable wind regime[1] will all be in a position to benefit from the lessons learned from this project, and the capacity and experience attained in Eritrea.

Furthermore, the Eritrean private sector as well as EEA and the Department of Energy will have been stimulated to participate in the development of the wind energy technology, making possible the manufacturing and/or maintenance of machine parts. The improved regulatory framework will attract private investors already present in the country, and positive economic experiences will enable them to replicate the project in other areas of the country.

Benefits to the global environment in the form of reduced CO_2 emissions will result, both from the demonstration sites of the project, and from the sustained development of wind energy technology in Eritrea.

B4. Target beneficiaries

The beneficiaries of the project can be split in two groups, (i) the ones that will benefit directly from the project and its activities, and (ii) the larger group that will benefit from its effects after project termination. To the first group belongs:

- the urban population in Assab, who will be secured a more stable and less polluting source of electricity, and an electricity grid ready for higher production in the future,
- the rural populations in the demonstration villages, a total of 977 households benefiting from the demonstration applications[2], who will benefit both directly and indirectly from the produced electricity and mechanical water pumping. Among other things one important benefit is the reduction of kerosene used for indoor lighting, which causes eye- and respiratory diseases. The local wind energy managers will also gain valuable experience, which can then be exported to other villages in the future. The replication potential is substantive: A total of 316 villages comprised of 60,000 households encounter a favorable wind and solar regime and will benefit from the introduction of renewable energy technologies. SMEs (ice-making for fishing companies, sea water pumping to saltfields, seawater desalination plants) will also benefit through productive use applications of wind. Provision of modern energy services for households and productive use applications will contribute directly to poverty reduction. In addition, households, which are grid-connected, will benefit from cheaper electricity prices once more wind farms are connected to the grid.
- EEA, which will be able to produce electricity cheaper than before, and which will develop its capacity in the area of wind energy applications,
- The Department of Energy, which will also gain experience with wind energy applications.

[1] The 316 identified villages comprise a total of 60.040 households, who are in a position to benefit from wind applications, ranging from electricity production to mechanical water pumping and hybrid systems with either diesel generators of solar PV systems.

[2] Be'rasoli 108, Rahaita 117, Haleb 200, Gaharo 99, Beilul 198, Gzgiza 225 and Dekemhare 30 households benefiting directly from the demonstration applications. The 99 households in Gaharo benefit from both electricity production and a water pumping system.

To the second group belongs:

- urban and rural populations all over Eritrea, in places with favourable wind regimes, who will benefit both directly and indirectly from reduced costs of electricity,
- the private sector in Eritrea, who will be able to participate both in the manufacturing and maintenance of wind energy systems, benefit from attractive investment opportunities made possible by a clearer legal and regulatory framework, and
- EEA and the Department of Energy, as above.

C. Project strategy and implementation arrangements

C1. Project design strategy

Providing electricity to rural areas is one of the targets of the Eritrean national energy policy. The development of a sustainable energy supply system in Eritrea is another one. To utilise domestic energy resources in order to reduce dependency on imported fossil fuels is a third objective. This project targets all three objectives. It is therefore an ideal fit when considering Eritrea's overall national energy policy. Furthermore, the GoE intends to continue to financially assist the ERTC in order to further promote decentralised rural electrification by means of utilising sustainable energy sources. The project design thus builds upon activities already initiated in Eritrea, and is a natural continuation of these.

In the development of this project, exhaustive consultations have taken place between the Department of Energy, the Ministry of National Development, consultants from Lahmeyer International, UNDP/GEF and the UNDP Eritrea office, the EEA, representatives of the private sector, and field visits have been carried out in all proposed demonstration villages. Furthermore, results from previous activities have been taken into account, including the following:

Results from the PDF-B project 'Wind Energy Applications in the Coastal Areas of Eritrea' were very important for the formulation of activities of this proposed project:

- The PDF-B provided the first complete picture of the available wind resources in southern Eritrea
- a Wind Information System (WIS) was developed and implemented at the ERTC. The ERTC is now able to quickly provide information on the wind resources at selected locations,
- the results of the wind data analysis show a high wind potential in and around Assab and in regions to the south of Assab. Average wind velocities generally decrease towards the north, with significant variation in the mountainous regions. This detailed information is now available for the identification and selection of suitable rural villages for wind-stand alone and wind hybrid systems in the wind-rich parts of Eritrea,
- the project furthermore provides evidence that the wind rich region of Assab would be an excellent example of the technical feasibility and economic competitiveness of grid connected wind parks in Eritrea. The necessary information for conceptual planning and economic assessment of the wind park Assab are now available. The analysis done so far shows that in Assab a wind park connected to the grid can be a cost-competitive contribution to Eritrea's overall electric power supply system, providing that GEF financial contributions will successfully remove the above-mentioned barriers.

The SIDA project 'Wind and Solar Assessment', finished in 2002, complements the PDF-B project and completes the database on wind resources. As part of the SIDA project a GIS database for renewable energy resources was created at the ERTC. The data and information available forms an ideal basis from which to expand rural electrification with sustainable energy utilisation to other parts of the country. It will also be useful for replicating the Assab wind park in other areas of the country.

The failed wind pilot turbine project in Massawa, part of the SIDA project, showed the importance of the know-how about manufacturers of small wind turbines and products in the market, which would be the appropriate for Eritrea according to the existing infrastructure (cranes, roads, etc.). Therefore, potential bidders for supplying the proper wind park equipment were already approached in order to guarantee their participation in the bidding process.

Other earlier projects such as 'Strengthening the Department of Energy', implemented in 1996 and 1997, indicate that the non-availability of electricity in rural areas can hinder commercial activities, resulting in poor living conditions for the people living there. Among others, this has resulted in population migration from rural areas to the cities, also to the city of Assab. It is expected that making electricity available in rural areas will help reduce the migrations of Eritreans from rural areas to the cities. This study also shows that biofuel is the main source of energy in Eritrea and it should be a top priority to search for possibilities to reduce the population's consumption of fuel wood. Although electricity is not the first choice as energy for cooking purposes in rural areas, the proposed project will analyse and test whether the utilisation of wind energy resources is a viable alternative for fuel wood for cooking at reasonable prices in high wind regions.

C2. Project implementation strategy

Initiating sustainable development of a new technology in Eritrea is a great challenge, and requires the careful involvement of all relevant stakeholders in the project, both in order to implement the project properly, and to set the scene for further development after project termination.

Implementation of the wind park in Assab will be implemented in close co-operation with the EEA. The EEA intends to participate in the financing and technical implementation, and later act as operator of the wind park. For future projects, the most probably organisational form is that EEA will be contracted in the frame of an O&M contract by the private wind park owner(s), or the EEA is itself a member of a wind park company.

All stand-alone and wind hybrid systems in rural areas will be implemented in close co-operation with the respective local communities. The community administrations will play an important role by collecting money from the end user beneficiaries, which will cover the running cost during the pilot phase. A rural electrification plan has already been initiated by the GoE and financial resources are being solicited to provide (fossil-fuel generated) electric power to selected rural villages, including some of the demonstration sites of this project. For these sites the wind-hybrid technology will be implemented to reduce fuel use and decrease production costs. The community administration will be in charge of both systems, as is traditional in Eritrea.

Implementation Plan. The flow chart given below provides a summary of the project's implementation plans. The time schedule shows that the total project duration will be three years, during which all three components will be implemented together. Connections between the different project parts have been considered in the time frame so as to make the missions of international experts as effective as possible thus minimising travelling costs especially with regard to the timing of the training seminars. There are several important milestones that must be achieved for the timely implementation of the project:

- Project office set-up: 2 months after project start
- Component 2: - Financial close: 5 months after project start
- - Wind park in operation: 16 months after project start
- Component 3: - All pilot systems in operation: 21 months after project start
- Project completion: 36 months after project start

The implementation plan is elaborated in a figure in an annex.

C3. Reasons for assistance from UNDP/GEF

The project is eligible for GEF funding under operational programme #6 because it will:

(i) directly reduce greenhouse gas emissions due to the installation and operation of a grid connected wind park and of isolated wind stand-alone and wind hybrid electricity supply systems, which will displace diesel-fired electricity production, both present and future, and

(ii) through its barrier removal activities kick-start the sustainable development of wind energy applications in Eritrea, thereby avoiding future emissions while bringing cheap electricity to the Eritrean population

UNDP is in a position to implement this project due to its large country presence, and its Energy and Environment practice area. UNDP has been involved both through the PDF-B, and subsequently in the final technical and financial analyses leading to this proposal. As implementing agency for GEF, UNDP has experience with capacity development and technical assistance in other areas of intervention, and is a trusted partner of the government.

C4. Special considerations

The environmental impacts of this project are positive in several ways. Firstly, contributing directly to CO_2 emission reductions in Eritrea, is the substitution of fossil fuel with wind energy for electricity production. Secondly, with an envisaged increased rate of rural electrification, firewood will slowly be replaced with (CO_2-neutral) electricity for cooking purposes[3], and kerosene for lighting will also be replaced. This will lead to improved health for women and children who gather around the smoky traditional stoves, reduced deforestation from reduced use of firewood, and improved quality of life for rural Eritreans, who will be less burdened with the collection of firewood, often to be found only several hours from the village. Deforestation is determined as a major cause for loss of biodiversity in Eritrea, and rural electrification will therefore also have associated benefits for the Eritrean biodiversity.

The innovative features of the project are:

(i) the implementation of state-of-the-art wind turbine technology,

(ii) the implementation of a small scale grid connected wind park in Assab

(iii) the stepwise increase of the share of wind power capacity of the total installed power capacity in an island grid consisting of diesel generators and wind turbines, in order to maximise the potential exploitation of the available wind resource,

(iv) analysing and demonstrating the technical and economical feasibility of replacing kerosene and wood fuel as the main energy sources for lighting and cooking, with wind generated electricity in regions with very high wind resources.

C5. Coordination arrangements

C5a. Project Management

The Project Management Unit. A project management unit (PMU) will be established, initially consisting of:

(i) a national project manager, who will be the day-to-day manager of project activities, and must be a person who has experience with both energy systems and project management,

(ii) a national professional assistant, who will assist the national project manager with technical skills and day-to-day management of the technical aspects of the project, and

(iii) a national secretary / administration assistant, who will be responsible for the administrative functioning of the PMU,

[3] The GoE is promoting the use of electric enjera cookers in electrified areas. Enjera is the local bread in Eritrea, used for most meals, and a highly energy intensive staple food in the country.

In addition, existing ERTC staff, initially 5 professional and 1 support staff, will dedicate 100% of their time during the lifetime of the project, to support the PMU. The PMU will report to the Department of Energy as the executing agency, and will receive supervision therefrom.

Technical Advisor. An international technical advisor, contracted through an international engineering company, will provide support to the PMU when needed. It is expected that the technical advisor will be able to oversee the project initiation, transfer wind energy project management capabilities to the national project manager, and assist in specialised tasks of the project (e.g. certain training components, assistance in the tendering document preparation and the tendering procedures, supervision of installation, etc.). An expert who fulfils the necessary qualification and who possesses the required professional background has therefore to be assigned for this task. The national project manager would then, during the course of the project, take more responsibility including continuous control over the management and supervision of the project.

The Executing Agency. The executing agency of the project will be the Department of Energy. DoE has been responsible for overseeing the implementation of several renewable energy projects in Eritrea, so it has the appropriate experience and knowledge for this role. The DoE will delegate technical work to the Energy Research and Training Centre (ERTC) that works rather independently from the DoE in its day-to-day business, but will retain the overall responsibility for the successful implementation of the project.

C5b. Other stakeholders

Eritrean Electric Authority (EEA). As the only national utility, EEA will play an important role in the project. The EEA will install and operate the Assab wind park under the proposed project. Regarding the rural wind energy project component, EEA has technicians from their own staff which already have the necessary educational background and professional experience to provide technical assistance for installation and O&M of the respective diesel part and the general electrical components of wind-diesel systems. Therefore such technicians will be included in training measures to extend their skills to the technical aspects of entire wind diesel systems. In the future EEA will therefore be a source of technical expertise for such kind of system implementation in Eritrea.

Local administrations. Another important participant in the rural pilot projects will be the local administrations in the selected villages. The village administrations will be responsible for (a) local administration of individual rural projects, (b) protection of the installed systems, (c) collection of fees/payments for electricity consumed by the rural villages, (d) documentation of statistical data regarding operation using guidelines prepared as part of this project, and (e) maintenance functions including assignment of technicians for this task (after having received proper training by the supplier and ERTC as prescribed in this project). This arrangement builds on a tradition in Eritrea where strong and independent community administrations manage village infrastructure.

Private Companies. As previously stated, a major goal of this project is to involve Eritrean private businesses in their country's wind energy sector. The project will focus on the private sector through information dissemination and the preparation of procedures, training of engineers, technicians and electricians, model contracts, PPAs etc.

C6. Counterpart support capacity

Since this is a long time priority for the GoE, it has committed substantial resources to this project, both in-kind and in-cash. These resources include staff time of the Department of Energy for project management and training, ERTC in particular, and cash contributions to wind energy hardware, grid reinforcement, and operation and maintenance of the installed systems. Furthermore representatives of

the GoE have been very active in the development of the present proposal, indicating a genuine commitment to the success of the project.

D. Development Objective

Global Objective

To reduce Eritrea's energy-related CO2 emissions by promoting both on-grid and off-grid wind energy systems as a substitute for fossil fuel based energy generation thus reducing the country's dependency on imported fossil fuel (diesel)

Development Objective

To promote socio-economic development and improve people's livelihood by facilitating access and affordability to modern, clean energy services

E. Immediate Objectives, Outputs, Activities

The three immediate objectives of the project are:

(1) To develop necessary personnel and institutional capacities to plan, install and operate on- and off grid wind systems and increase awareness amongst decision makers in governmental and private institutions both at the community and central level.

(2) To install a small wind farm in Assab and integrate the wind generated electricity into an existing conventional grid thus demonstrating that on-grid wind energy is technical, financially, and institutionally feasible and can be a least cost electricity supply possibility in Eritrea at high wind speed sites.

(3) To install eight small scale decentralised wind stand-alone and wind-diesel hybrid systems in selected rural wind rich villages and production sites of Eritrea to demonstrate the technical, financial, institutional and socio-economic viability.

Under immediate objective 1 outputs and activities relate to capacity building, strengthening of institutions and raising of awareness. For personnel and institutional capacity building public and semi public authorities such as the Ministry of Energy and Mines and its ERTC and the public utility (EEA) and also the private sector companies are targeted. The awareness raising component is specifically directed at decision makers in the public and private sector including potential end-users of wind energy applications.

Under immediate objectives 2 outputs and activities relate to demonstrate to the Eritrean authorities, private companies, and the public that grid connected wind parks at sites with high wind speeds are economical effective, can contribute to the overall reduction of electricity generation cost, and can reduce the amount of the national budget necessary for oil imports. So far, there are no grid connected wind parks in Eritrea. In the existing grids, electricity is supplied solely by means of power generation sets, fired with diesel fuel. However, due to the good wind regimes, the natural frame conditions in Eritrea would allow to save at least a part of the diesel by means of feeding wind electricity in the grid. Under this component private sector involvement in financing, installing and operating the wind farm will be promoted.

Under immediate objective 3 outputs and activities relate to demonstrating in five villages and 3 production sites wind-diesel hybrid and wind stand alone systems. Sites in the Southern and Northern Red Sea Coastal Zone were selected for this pilot phase.

Table: Demonstration Projects

Type of System	*Number of Projects*	*Villages/ Production Sites*	*Power Output kW*
Wind-diesel hybrids, integrated to existing or planned diesel system	3	Be`rasoli, Rahaita, Haleb*	30, 30, 30
Wind stand alone system, rural village electrification	3	Gaharo, Beilul, Gzgiza	5, 10, 10
Wind water pumping	2	Gaharo*, Dekemhare*	3, 3
Total	**8**		

* These sites are exclusively focussing on productive and social use applications (irrigation for agriculture, drinking water pumping and electricity for a boat factory). At the other five villages the generated electricity will be used for household electrification and small scale businesses.

The demonstration projects will assist the Eritrean institutions and experts to obtain practical experience with this kind of technology, its implementation and operation. This component focuses on wind energy as one possibility for off-grid rural village electrification and also to demonstrate wind technologies for productive uses. It is envisaged to develop, establish and verify adequate procedures for subsequent implementation of renewable (particularly wind) energy projects as part of the overall rural electrification programme in Eritrea. Such procedures should take adequately into account that the government needs to provide the interested communities and SMEs with adequate financing mechanism, which may also include financial incentives.

Outputs and Activities

Each of the three immediate objectives will be achieved by producing a series of related outputs, which in turn will be produced by carrying out associated activities.

Immediate Objective 1: To develop necessary personnel and institutional capacities to plan, install and operate on- and off grid wind systems and increase awareness amongst decision makers in governmental and private institutions both at the community and central level.

Output 1.1: The necessary skills within the utility (EEA) for grid connected wind park planning, installation, operation and maintenance developed.

> Activity 1.1.1: Carry out training seminars and on-the job training courses for operation personnel at the wind park in Assab as well as headquarters staff of EEA in Asmara. The reason is that in the future new wind parks are expected in the ICS Asmara-Massawa because the electricity demand is higher here. Also more increase of the electricity demand is expected in the ICS. Therefore, the respective know-how has to be put on a wide basis inside EEA and not only with regard to the operation personnel in Assab.
>
> Activity 1.1.2: Train EEA and DoE staff with regard to the supervision and acceptance of all civil, electrical and mechanical works.

Output 1.2: ERTC strengthened so that it can take the position of a national centre of competence for wind energy technology, to make available to the governmental organisations the necessary professional expertise, which such authorities need for giving approvals, supervision and follow-up of wind energy projects.

> Activity 1.2.1: Establish and institutionalise a Project Management Unit (PMU) within ERTC
>
> Activity 1.2.2: Carry out specific training measures under ERTC's roof for public and private

sector experts such as basic seminars and train-the-trainer seminars to extend the general knowledge in technology, economics, environmental benefits and risks, installation, commissioning, certification and O&M of wind energy technologies.

Activity 1.2.3: Develop and establish a renewable energy data bank at the ERTC. Such data bank shall contain, on the one hand, the resource data of wind and solar energy, which are necessary for identification, conceptual layout and cost assessment for renewable energy projects. On the other hand, the data bank shall contain an overview of the operation data of the installed systems.

Output 1.3: Technicians, electricians and engineers in the private sector trained, so that sufficient experts are available on the national market for future projects.

Activity 1.3.1: Hold seminars and training-on-the-job activities during the installation and commissioning phase of the wind park (training to be provided from the wind turbine supplier). Training will focus on installation and particularly O&M activities.

Output 1.4: Awareness about the viability of wind energy amongst decision makers at all levels (including communities) and the general public increased.

Activity 1.4.1: Carry out awareness campaigns for community leaders.

Activity 1.4.2: Carry out awareness campaigns targeted at leaders in the private and public sector at the central level

Activity 1.4.3: Carry out awareness campaigns for the general public

Immediate Objective 2: To install a wind farm in Assab and integrate the wind generated electricity into an existing conventional grid thus demonstrating that on-grid wind energy is technical, financially, and institutionally feasible and can be a least cost electricity supply possibility in Eritrea at high wind speed sites.

Output 2.1: Necessary contractual framework, including model PPA and wheeling agreement, for a first wind park connected to the Assab grid prepared.

Activity 2.1.1: Finalize the contractual arrangements for the wind park project until financial closure.

Activity 2.1.2: Prepare model contracts particularly for the power purchase and wheeling agreements for grid connected renewable energy projects in Eritrea.

Activity 2.1.3: Prepare tender documents and the subsequent accompaniment of the tender procedure, the contract negotiations and the contract preparation, including the necessary training-on-the-job for the involved national companies and EEA.

Output 2.2: A small wind park in Assab connected to the grid having a capacity of 750 kW installed and in operation.

Activity 2.2.1: Formulate a suitable optimal operation strategy for the wind park Assab.

Activity 2.2.2: Disseminate operation results in order to attract further interest in the private sector in further investments in similar kind of projects in the future.

Activity 2.2.3: Procure and install the grid connection cable, and the wind park substation

Activity 2.2.4: Reinforce the Assab grid prior to the installation of the wind park

Subactivity 2.2.4.1: Rehabilitate three cabins in the SCS Assab in order to improve the overall technical reliability of the system

Activity 2.2.5: Install the Wind Park consisting of three 250kW turbines

Activity 2.2.6: Operate the Wind Park and evaluate the performance

Immediate objective 3: To install eight small scale decentralised wind stand-alone and wind-diesel hybrid systems in selected rural wind rich villages and production sites of Eritrea to demonstrate the technical, financial, institutional and socio-economic viability.

Output 3.1: Procedures, particularly between local, regional and central administration levels and across line ministries, which allow the identification, implementation and operation of rural, renewable electrification projects, particularly wind, developed and tested.

Activity 3.1.1: Analyse and document existing procedures, together with a precise delegation of responsibilities for the initiation, development and implementation of off-grid wind energy projects.

Activity 3.1.1: Test the procedures in selected villages and production sites.

Output 3.2: Viable financing mechanisms for small-scale off-grid wind systems explored, developed and tested.

Activity 3.2.1: Identify financing options successfully applied in other countries and associated lessons learnt

Activity 3.2.2: Test the most promising models for the Eritrean context, including FMIs, fee for service system, soft loans, etc.

Output 3.3: Five diesel-wind hybrid and three wind stand-alone systems installed, maintained and operated.

Activity 3.3.1: Prepare, tender and comission the eight pilot projects.

Activity 3.3.2: Install the eight pilot projects.

Activity 3.3.3: Operate and maintain the systems

Activity 3.3.3: Analyze and disseminate operation results after 1 year of operation and in subsequent years.

F. Inputs

F1. Government of Eritrea, Department of Energy

The Government of Eritrea will provide funding of USD 2,000,000 in-cash to the project. These funds will be channelled through DoE, ERTC and EEA. In addition, in-kind contributions of USD 40,000 have been calculated consisting mainly of salaries of ERTC and DoE staff.

F2. UNDP

UNDP has provided USD 26,500 from TRAC resources to develop the project proposal.

F3. GEF

GEF has provided a PDF B grant of 315,000 to develop the proposal and has agreed to finance USD 1,950,561 of this full size project.

G. Sustainability and risks

G1. Sustainability

This project is a barrier removal project, and thus has an unfailing focus on sustainability.

- the demonstration sites will show all actors in this field the economical and technical feasibility of using wind power for electricity production and/or mechanical pumping,
- information will be disseminated concerning the progress of the demonstration sites, in order to enable all interested parties to evaluate the future possibilities for themselves,
- a data bank containing nation-wide information on both wind and solar resources will be established in ERTC, which can form the basis for future analysis of the possibilities to extend wind energy applications to other areas of Eritrea,

The implementation of wind stand-alone and wind hybrid systems and the grid-connected wind park will be an excellent model for future power projects, based on the utilisation of renewable energies. Preliminary estimates show that the potential for replicating these grid connected wind parks in Eritrea by the year 2010 is a factor of between 15 and 25 (15 to 25 times the rated power of the grid connected wind turbines which would be installed during this project). The potential for replication of small scale wind stand alone and hybrid systems in the southern parts of Eritrea and in the highlands is a factor of around 30 to 40, related to the number of demonstration projects. In other words: In addition to the 8 pilot villages/ production sites there are approximately 300 villages/ production sites with favourable wind regimes. The potential for replication of small scale wind as a stand alone application or in a hybrid system with PV and/or diesel for rural electrification is around 25 to 35 MW for entire Eritrea.

Replication Potential for Off-Grid Systems

Project Phase

Project area/location name	*Nr. of Villages*	*Benef. Households*	*Renewable source*	*Proposed technology*
Berasoli	1	108	Wind - Average speed 6.8 m/s	Wind hybrid
Rahaita	1	117	Wind - Average speed 6.8 m/s	Wind hybrid
Haleb	-	-	Wind - Average speed 7.3 m/s	Wind hybrid
Gaharo	1	99	Wind - Average speed 7.0 m/s	Wind stand alone
Beilul	1	198	Wind - Average speed 5.8 m/s	Wind stand alone
Gizgiza	1	225	Wind - Average speed 6.2 m/s	Wind stand alone
Gaharo	-	-	Wind - Average speed 7.0 m/s	Wind water pumping
Dekemhare	1	30	Wind - Average speed 6.0 m/s	Wind water pumping
Total	**6**	**777**		

Replication Potential

Project area/location name	*Nr. of Villages*	*Benef. Households*	*Renewable source*	*Proposed technology*
Ketema Aseb (Gaharo area)	21	3,140	Wind power Class 7 (7.0 - 9.4 m/s)	Wind stand alone and hybrid
Ketema Aseb (Assab area)	5	750	Wind power Class 6 (6.4 - 7.0 m/s)	Wind stand alone and hybrid
Gizgiza area	54	9,370	Wind power Class 5 (6.0 - 6.4 m/s)	Wind stand alone and hybrid
	80	**13,260**		
Dekemhare area	47	17,130	Wind power Class 4 (5.6 - 6.0 m/s)	Wind water pumping
Kohaito area	41	3,930	Wind power Class 4 (5.6 - 6.0 m/s)	Wind water pumping
	88	**21,060**		
Areza area	87	19,780	Wind power Class 4 + Solar 6 kWh/m_2/day	Wind/PV hybrid systems
Kerkebet area	61	5,940	Wind power Class 4 + Solar 6 kWh/m_2/day	Wind/PV hybrid systems
	148	**25,720**		
Total	**316**	**60,040**		

Sources: Ministry of Local Government
Population estimation of Eritrea 2001
Cartography Unit – March 2002
Renewable resources (wind and solar) assessment
SIDA (year 2002) and UNDP/LI (year 1999)

Low electricity demand, a potential risk to the sustainability and replication potential of the project, has been minimised through an initially conservative size for both the Assab wind park and the off-grid installations. Sustainability and replicability is ensured because (1) wind favourable sites within acceptable distance to the ICS exist, (2) the ICS grid is sufficiently strong so that a wind park can without significant grid restrictions be integrated and (3) sufficient wind measurements for such sites will be available in time before the final decision of the selected wind park site will be taken.

In terms of financial sustainability it is important to consider the hard currency savings. Total savings in expenses for diesel import after installation of 750kW wind park and off-grid wind systems in 8 villages/ production sites amounts to USD 288,500 per year. Over the 10 years financial life of the project savings of USD 2,890,000 could be realized. Over the lifetime of the equipment (20 years) savings of 5,780,000 could be realized. This figure does not take into account the expected installation of additional wind parks and off-grid wind systems after the 3-year pilot project is finished. The savings are expected to be substantially higher because of this replication effect. In addition tariff subsidies could be reduced because generation costs will decrease. This will be an additional saving for the GoE.

The economic attractiveness of wind technology in rural off-grid areas will divert some of the investments towards purchase of wind-diesel hybrid or wind stand-alone systems or even small wind parks. Traditionally the capital costs for buying and installing diesel gen-sets are covered jointly by the central government and the community administration and are not recovered. This is likely to continue since the rural incomes are still very low. O&M costs are covered by collecting fees from the end consumers. This project will analyse, suggest and test viable financing mechanisms to accelerate market penetration with wind technologies. If adequate financing mechanisms are in place it is expected that the demand for wind technologies can be met, given the economic and financial attractiveness of wind in Eritrea. Viable financing mechanisms will be explored including the following:

- ✓ Payment capacity of rural households and SMEs
- ✓ Soft loans for capital investment from commercial and development banks and micro-finance institutions
- ✓ Fee for service model

G2. Risks

Technical Risks. A technical risk which is foreseeable at this point and which remains only to a certain extent is that the actual wind speeds in some of the selected villages and production sites may be lower than expected. This risk does not exist for the wind park Assab where measurements very close to the site are now available for more than four years. In the rural areas measurements have been taken at fewer locations and the method for estimating of the wind resources at the many other sites without measurements bear – as it is with all methods available for such kind of wind data correlation and long term wind data estimation - certain insecurity. Primary indicators show that the wind resources south of Assab are so high, however, that some reductions in the actual wind resources compared to the calculated ones will not affect the conclusion that utilising wind energy in that region would be a competitive technology for rural electrification. The case is similar in the highlands (Gzgiza and Dekemhare), where wind measurements from the SIDA project show good wind regimes.

Since industrial facilities to produce components of wind energy systems are presently not available in Eritrea, almost all of the equipment needs to be imported. This bears an implementation risk since equipment, which eventually needs to be replaced during the course of the project, needs to be imported as well, and is therefore costly. This risk has been addressed by securing that suppliers will provide with sufficient spare parts even for the period of time after the pilot phase is over so that it is guaranteed that the pilot systems will not terminate operation due to non-availability of financial resources needed for spare part supply. Offers for wind turbines size 250 kW, planned for the Assab wind park, have been obtained for this purpose.

Table: Wind Data Information for proposed Project Locations

Project Location	Wind Data Measurements	Average Wind speed	Period of Measurements	Remarks
Assab	Yes	7.9 m/s	4 years	Very good Data recovery rate
Rahaita	No	6.8 m/s	---	From Wind Information System of LI
Gaharo	Yes	7.0 m/s	3 years	Good Data recovery rate
Beilul	No	5.8 m/s	---	From Wind Information System of LI
Be'rasoli	No	6.8 m/s	---	From Wind Information System of LI
Gzgiza	Yes	6.2 m/s	3 years	Good Data recovery rate
Haleb	No	7.3 m/s	---	From Wind Information System of LI
Dekemhare	Yes	6.0 m/s	3 years	Good Data recovery rate

Implementation Risks. In rural villages the education level is poor and there is a risk that villagers are not able to adequately manage the wind energy technology systems. A lack of technical experience and know-how also exists within the EEA, especially regarding the operation of grid connected wind parks. The project provides for training, however, which includes instruction for EEA operation staff. It is further envisaged that each pilot system installed in rural villages will be accompanied by a careful selection of local villagers who will be properly trained to operate the system. During the pilot phase a programme of regular visits to each of the pilot sites is planned. These visits will ensure that the operation performance of the systems is continuously and competently supervised. The guidance provided for training locals will be followed by a formal review of performance using a standard checklist to determine whether the locals can competently operate the system on their own.

The implementation risk associated with a low electricity demand in Assab was extremely reduced with a conservative wind park size for this pilot phase. Any demand scenario for Assab, on which basis the modular expansion of the wind park can be estimated, is presently vague, due to the uncertain economic development under the present Eritrean conditions.

H. Prior obligations and prerequisites

H1. Obligations

Eritrea ratified the UNFCCC on the 24th of April 1995. At the Rio Conference, where the UNFCCC was elaborated, energy played a major role because energy supply and use was recognized as one of the major causes of environmental degradation both at the local level and worldwide. Sustainable energy services are at the same time absolutely essential for development. Eritrea, in an intense process of rebuilding the country after 30 years of independence struggle and a post-independence conflict with Ethiopia, is therefore very much in need of sustainable and reliable energy services for the development of both its urban and rural areas. At the same time Eritrea tries to live up to its commitment to the UNFCCC, to assist in *"the stabilization of greenhouse gas concentration in the atmosphere at a level that will prevent dangerous anthropogenic interference with the climate system"*. Eritrea is already seeing negative effects of climate change, through increased frequency of droughts, which plague the country and make it heavily dependent on food aid.

The Government of Eritrea thus has an array of reasons for removing existing barriers for a sustainable development of a clean and cost-effective energy resource such as wind energy.

H2. Prerequisites

(i) GoE will support the project in cash and in kind as per the project budget
(ii) GoE will provide data to project staff and consultants as may be required for the implementation of the project activities
(iii) GoE will provide office space for the PMU, and will second staff as per the project budget
(iv) GoE will pay import duties as per the project budget

Assistance for the project will be provided only if the pre-requisites stipulated above have been fulfilled or are likely to be fulfilled. If anticipated fulfilment of one or more prerequisites fails to materialise, UNDP/GEF may, at its discretion, either suspend or terminate its assistance.

I. Project review, reporting and evaluation

Monitoring of results and lesson learning is an essential task in which all stakeholders of the project should be constantly involved.

The daily monitoring of the project will be conducted by the PMU, which will submit

- progress reports every six months
- annual reports every year, and
- a final report.

Each progress report should review the activities for the previous reporting period and provide an assessment of the actual project status. It should also provide an updated time schedule based upon the project status.

Annual Project Report: The Project Management Unit reports annually to the Executing Agency, UNDP and GEF on the project output achievements and outcomes. This is done by preparing Annual Project Reports (APR) after consultation with stakeholders. The new APR/ GEF Project Implementation Report (PIR) format is used. The UNDP Country Office will use the APR to assess performance of the project management and to determine strategies for the future. It will also be supplied to the GEF Monitoring & Evaluation Team.

Evaluation: At the end of the project the executing agency organises an independent evaluation of the project. If necessary, an independent evaluation will also be conducted at the mid-term point of the project life.

Monitoring & Operation of Installed Systems: An evaluation of the operation statistics of the wind park in Assab will take place after one year of operation. Targets will be set regarding technical availability and performance. These targets will be defined and agreed upon beforehand by the operator, the wind turbine supplier and the project management. Actual achieved availability and performance of the systems will be compared with those targets The O&M contractor of the wind park will be required to submit regular operation reports containing key operational data beforehand so that failures can be identified before the one year evaluation.

For the pilot systems installed in the rural areas a programme of regular visits will be prepared before installation. Together with establishment of communication lines and procedures between the local operators and ERTC, these visits will allow for the close monitoring of the functioning of the system and the performance of the local operators. In addition, the implementation of a database at the ERTC will be a useful tool for reviewing operational data of the pilot systems. This will allow for

comprehensive comparisons of the different systems as well as comparisons of the various systems' behaviour over time.

Monitoring by UNDP: UNDP will keep close contact with all partners of the project, especially the project management, and consultants during their assignments. UNDP will also join the project management in field visits, and assist as appropriate in the resolution of any problems that might arise during project implementation. As the GEF implementing agency for this project, UNDP also assumes responsibility for its implementation, as outlined in its National Execution Manual.

J. Legal context

This project document shall be the instrument referred to as such in the Agreement between the United Nations and the Government of Eritrea signed on 11 June 1994.

As support to the executing agency, the UNDP country office will provide support services for some of the activities of the project as identified and agreed upon by all parties, especially in the following areas:

(i) identification and recruitment of the recruited personnel/experts to undertake specific activities under the project,
(ii) identification and facilitation of training services,
(iii) procurement of goods and services.

The UNDP country office will charge 3% of the total project budget for the provision of all the identified and agreed upon services.

The following types of revisions may be made to this Programme Document with the signature of UNDP Resident Representative only, provided he/she is assured that the other signatories of the programme document have no objection to the proposed changes:

a) Revisions in, or in addition to, any of the annexes of the programme document

b) Revision which do not involve significant changes in the immediate outcomes, outputs or activities of the programme, but are caused by the re-arrangement of inputs already agreed upon or by cost increases due to inflation; and

c) Mandatory annual revisions, which re-phase the delivery of agreed programme inputs, or reflect increased expenditure or other costs due to inflation or take into account agency expenditure flexibility.

K. Budget

Project Budget by Component (US Dollar)

Component Description	**GEF Budget**	**GoE Budget**	**Total**
Component 1: Capacity Development	612,648	98,858	711,506
Component 2: On-Grid Wind Park	717,783	1,565,092	2,282,875
Component 3: Off-Grid Wind Systems	620,130	336,050	956,180
Total	**1,950,561**	**2,000,000**	**3,950,561**

For a detailed budget breakdown please see annexes.

LIST OF ANNEXES

ANNEX 1: Incremental Cost Calculation

ANNEX 2: UNDP Budget (Exel table in separate file, not attached for STAP review)

ANNEX 3: Draft Workplan/ Implementation Plan (Exel table in separate file, not attached for STAP review)

ANNEX 4: Logical Framework Matrix (already attached in Executive Summary annex)

ANNEX 5: Terms of Reference for Project Staff (not attached for STAP review)

ANNEX 6: Co-financing commitment letter (not attached for STAP review)

ANNEX 7: GEF focal point endorsement letter (not attached for STAP review)

Annex 1: Incremental Cost Calculation

Component 1

Component 1 activities basically consist of technical assistance (e.g. training, institutional strengthening, awareness raising, etc.). Component 1 intends to build up the necessary domestic capacity for renewable energy project development and implementation in Eritrea, particularly for wind energy projects. Such activities are necessary to guarantee that the implementation of the wind energy technology can continue self-sustainable in Eritrea after the end of this proposed GEF project. In addition, an important objective of Component 1 is to assure that Eritrea's future electricity supply plans include consideration of wind energy technology, which under circumstances such as those in Eritrea deserves as much attention as conventional electricity supply technologies. Activities of component 1 are barrier removal activities towards the goal of achieving a long-term sustainable renewable energy technology introduction in Eritrea.

The total costs for component 1 have been estimated at 0,673 Mil. US$ (this includes the necessary project management activities, for the entire project for a three year period). Of this, governmental contribution would amount to 0,060 Mil US$, which would mainly cover the ERTC staff salaries and pay the duties and taxes for imported hardware and software. The remaining GEF eligible part is 0.612 Mil US$.

Component 2

Baseline. The business-as-usual situation, at the site of the wind park in Assab, is the continuation of the electricity supply by means of using the existing diesel generation sets. Construction of a new power station in Assab would not be planned nor would it be planned to rehabilitate the existing ones in the near future. The installed capacity at present exceeds the total load. Furthermore the EEA diesel generation sets have reached about half of their entire lifetime. The diesel generation sets of the port authority are older, but they are still in good condition and no exchange of them due to achievement of the end of lifetime is planned.

The baseline case is therefore the following:

Baseline Case
The electricity supply in Assab will continue by operating the existing diesel generation sets.

The GEF Alternative. The GEF alternative is the implementation of one grid connected wind park in Eritrea. By this means the existing barriers for grid connected wind parks in Eritrea will be removed and the development of further grid connected wind parks will be made possible. Due to the very favourable wind conditions, the first choice is the integration of a wind park to the SCS in Assab. This GEF alternative will consist of a small wind park with a rated capacity of 750 kW that will be installed within two years.

There are several issues to be considered regarding the determination of the Incremental cost for the grid connected wind park in Assab:

- The grid system in Assab needs some reinforcement to make it technically feasible to integrate wind power into the system. Additional power switches are needed in several cabins, a specially adapted operation and control strategy that allows the parallel operation of diesel

generation sets and wind turbines must be prepared and established, and a strategy to test the readiness of the necessary grid connections must be developed. Furthermore, a grid connection must be installed. 50% of the grid reinforcement and grid connection costs will be covered by GEF.

- The wind park would result in significant hard currency savings. Total savings in expenses for diesel import after installation of 750kW wind park amounts to USD 286,813 per year. The Net Present Value (NPV) of cost savings over the lifetime of the equipment (20 years) amount to USD 2,872,945. This figure does not take into account the expected installation of additional wind parks and off-grid wind systems after the 3-year pilot project is finished. The savings are expected to be substantially higher because of this replication effect. In addition tariff subsidies could be reduced because generation costs will decrease.

- The wind park generated electricity will be sold to EEA at a price which is to be determined. For this calculation it is assumed that the feed in price is 5,9 cent US/ kWh (80 cent Nakfa/ kWh). This feed in price is 35% cheaper than the current generation cost per kWh which is at about 9,0 cent US (1,22 Nakfa). The annual electricity generation, taking into account a capacity factor of 44%, is 2,490 MWh/ year. The revenue generated is USD 148,124/ year or, calculated over 20 years, the NPV of income would be USD 1,483,726. Compared to the total investment costs of USD 1,027,000 these numbers clearly show the profitability of the wind park. Since these calculations have been done the import price if diesel has increased by approximately 30% which makes the wind park even more profitable. Please find below the calculation tables:

Input Data, Wind park Assab		
Costs:		
Total investment in US$		1,027,000
Total O&M in US&/y		40,053
Annual increase of O&M cost in %		1
Income calculation figures:		
Annual electricity generation in MWh/y		2,490
Contractual feed-inPrice in Nakfa/kWh		0.800
Contractual feed-inPrice in US$/kWh		0.059
Saving of Costs		
Fuel costs of EEA in US$/l		0.421
Fuel savings in 1000 l/y		682
CO2 savings in t/y		1,701
Financing of investment		
Equity:		
Percentage of total investment		30
Amount in US$		308,100
Loan I:		
Percentage of total investment		70
Amount in US$		718,900
Interest rate		8
Payback free period		2
Number of payback years		12
Grant (GEF contribution)		
Percentage of total investment		0
Amount in US$		0

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Year from start		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Income in US$/year		148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124
Expenses:																						
O&M in US$/y		0	0	40,858	41,267	41,679	42,096	42,517	42,942	43,372	43,805	44,243	44,686	45,133	45,584	46,040	46,500	46,965	47,435	47,909	48,388	48,872
Loan I																						
Interest in US$/y		57,512	57,512	52,719	47,927	43,134	38,341	33,549	28,756	23,963	19,171	14,378	9,585	4,793	0	0	0	0	0	0	0	0
Payback in US$/y		0	0	59,908	59,908	59,908	59,908	59,908	59,908	59,908	59,908	59,908	59,908	59,908	59,908	0	0	0	0	0	0	0
Total payed back in US$		0	0	59,908	119,817	179,725	239,633	299,542	359,450	419,358	479,267	539,175	599,083	658,992	718,900	718,900	718,900	718,900	718,900	718,900	718,900	718,900
Total Costs in US$		57,512	57,512	112,628	107,835	103,042	98,250	93,457	88,664	83,872	79,079	74,286	69,494	64,701	59,908	0	0	0	0	0	0	0
Total Expenses in US$		57,512	57,512	153,486	149,102	144,722	140,346	135,974	131,607	127,243	122,884	118,530	114,180	109,834	105,492	46,040	46,500	46,965	47,435	47,909	48,388	48,872
Profit/Loss (-) in US$ before interest payment	-1,027,000	148,124	148,124	47,357	46,949	46,536	46,119	45,698	45,273	44,844	44,410	43,972	43,530	43,083	42,631	102,084	101,623	101,158	100,689	100,214	99,735	99,251
Profit/Loss (-) in US$ after interest payment	-308,100	90,612	90,612	-5,362	-978	3,402	7,778	12,150	16,517	20,880	25,239	29,594	33,944	38,290	42,631	102,084	101,623	101,158	100,689	100,214	99,735	99,251
Profit/Loss (-) in US$ after interest payment	-1,027,000	90,612	90,612	-5,362	-978	3,402	7,778	12,150	16,517	20,880	25,239	29,594	33,944	38,290	42,631	102,084	101,623	101,158	100,689	100,214	99,735	99,251
Sum of Profit/Loss in US$		90,612	181,223	175,861	174,883	178,286	186,064	198,213	214,730	235,611	260,850	290,444	324,388	362,678	405,310	507,393	609,017	710,175	810,864	911,078	1,010,814	1,110,065

ROE	12%

Internal Interest Rate for NPV 8%

Incremental Cost Calculation

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Year from start		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Cost savings through fuel import red. per year in US$		286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813	286,813

NPV of cost savings in US$	2,872,945

NPV of expenses in US$, incl. investment payment in year 0	1,387,334

Incremental Cost Calculation

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Year from start		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Income in US$/year (Revenue generated)		148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124	148,124

NPV of Income (Revenue generated) in US$	1,483,726

GEF co-financing of the wind park can only leverage the cost savings due to reduced need of diesel oil. The investment cost of the wind park itself need therefore to be balanced against the net present value of those cost savings, calculated over the lifetime of the project. These net present value costs are under the base line costs. Since they are higher than the investment cost of the wind park itself, the increment is zero (We have defined increment cost as zero in case the resulting value is negative). The necessary investment cost for the wind park will therefore come from the Government of Eritrea.

It should be pointed out here, that this comparison neglects the O&M costs of the wind park and is therefore not representative of the economic competitiveness of the project. O&M costs (including costs for land rent, insurance, spare parts, etc.) are also not GEF eligible, since they will be refinanced out of the selling of electricity to the power utility. The respective O&M costs have therefore be added in the column of the baseline.

As can be seen, the total incremental costs are 1,12 Mil. US$. Of this, costs which are due to technical barrier because of a weak existing grid for wind energy generation purposes are assumed by the GoE and EEA at 50%, as well as local taxes at 100 %. This results in incremental costs eligible for GEF financing of approx. 0.71 Mil. US$. 0.41 Mil. US$ of this would be used for hardware cost components, 0.27 Mil. US$ would be used for barrier removal and technical assistance to implement the project. The following table shows the total calculation of the incremental cost per cost component. The calculation of the investment cost for the hardware components is based upon the cost estimations carried out during the PDF B phase and quotations from potential suppliers collected in April 2003.

Table: Incremental cost calculation, Grid Connected Wind Park (component 2)

Incremental Cost Calculation				
Component 2: Grid connected wind parks in Eritrea.				
	Baseline in US$	***GEF Alternative in US$***	***Increment in US$***	***GEF Contribution***
Grid Reinforcement prior to the installation of the wind park				
Cabin Port Office	0	197.000	197.000	98.500
Cabin Military Camp	0	135.000	135.000	67.500
Local Tax on Equipment	0	13.280	13.280	0
Grid Optimisation for Wind Park Integration:	0	35.400	35.400	35.400
Subtotal	**0**	**380.680**	**380.680**	**201.400**
Finalisation of financial arrangements up to financial close				
Subtotal	**0**	**20.400**	**20.400**	**20.400**
Preparation of model contracts (contractual framework)				
Subtotal	**0**	**35.400**	**35.400**	**35.400**
Tendering, company selection, contract negotiation and contract preparation of Turnkey contract				
Subtotal	**0**	**51.000**	**51.000**	**51.000**
Grid connection				
EBCA Cabin	0	135.000	135.000	67.500
Power Cable, 120 mm²	0	80.000	80.000	40.000
Wind park Station	0	140.000	140.000	70.000
Local Tax on Equipment	0	14.200	14.200	0
Subtotal	**0**	**369.200**	**369.200**	**177.500**
Installation of Wind Park				
Total Cost International Consultant	0	82.203	82.203	82.203
Cost National Consultant	0	8.000	8.000	8.000
Investment Cost Control strategy	0	45.000	45.000	45.000
Investment Cost Wind Park				
Wind turbine		765.000		
Two years Defects Liability Period		25.000		
Foundation		40.000		
Erection, crane work		35.000		
Transport (by ship)		27.000		
Transformers		18.000		
LV cabling		67.000		
Planning		15.000		
Contingencies		35.000		
Total Investment Cost wind park		1.027.000	0	0
Local Tax on Equipment	0	41.080	41.080	0
Subtotal	**0**	**1.203.283**	**176.283**	**135.203**
Suppliers Training				
Subtotal	**0**	**25.000**	**25.000**	**25.000**
Operation of Wind Park for a period of one year; evaluation of operation				
Subtotal	**80.106**	**117.806**	**37.700**	**37.700**
Total	**80.106**	**2.202.769**	**1.095.663**	**683.603**
5 % contingencies				**34.180**
Total				**717.783**
Of the Total are Hardware Costs, incl. Contingencies:				**407.925**
Of the Total are for Barrier Removal and Technical Assistance, incl. Contingencies:				**309.858**

Global and Domestic Benefits. The global environmental objective is aimed at reducing the necessary fuel input to supply the given electric load and thus reducing the resulting GHG[4] emissions. Apart from direct GHG emission reduction, a significant expected indirect benefit can be seen in the demonstration character of the project in Eritrea. This project will demonstrate for the first time the technically and economically viable parallel operation of a wind park parallel to EEA's grid.
Apart from the global benefits, the project also has domestic benefits. The following table provides an overview of the global and domestic benefits.

Table: Global and domestic benefits of the Wind Park Assab

	Baseline	**Alternative**	**Increment**
Global	GHG emissions	Reduction of GHG emissions	1,700 tons CO_2/year
Domestic	NOx emissions	Reduction of NOx emissions	Not quantified
Domestic	CO emissions	Reduction of CO emissions	Not quantified
Domestic	Lubricant consumption	Reduction of lubricants	Not quantified
Domestic	Pollution due to used lubricant	Reduction of pollution	Not quantified
Domestic	high fuel consumption	Fuel savings	682 * 10^3 l/year
Domestic	Corresponding high expenses for fuel import	Corresponding savings in expenses for fuel import	287 * 10^3 US$/year
Domestic	No demonstration	Demonstration of the feasibility of grid connected wind park projects for EEA, GoE and Eritrean population.	
Domestic	direct job creation: No additional jobs	1.5 jobs for O&M, several restricted time jobs during construction and installation	1.5 jobs, several restricted time jobs during construction and installation
Domestic	indirect job creation: none	Job creation through initialisation of further wind parks in Assab and in the ICS Asmara-Massawa; indirect job creation in private sector (Consultant, construction companies)	

Component 3

Baseline. Without the GEF financed project, rural electrification would continue on its current trend. The baseline case is therefore the following:

[4] GHG: Greenhouse Gases, mainly CO_2 and CH_4

Baseline Case: Eritrea will have a very low level of rural electrification. Villages in close proximity to the ICS and to the SCS of Assab will eventually receive electric power as the grid is extended. Rural villages further from the grid will obtain a low level of electric supply through isolated electricity generation systems. The government will continue its efforts to develop the rural areas and to encourage economic activities therein. Regarding the investigation area of the PDF B activity (southern part of Eritrea), the following will be done: (1) increase the number of agricultural projects and extend already existing agricultural projects, (2) encourage fishing activities in the coastal villages of Eritrea, and (3) set-up a boat building industry in the far south of Assab: The excellent road Massawa-Assab will extend trade and small scale business along the road. Alongside with that there will be electrification of rural villages in the southern part of Eritrea and in villages in central and northern Eritrea with long distances to the ICS, but only on a very low level. This will mainly be accomplished by supplying a few public buildings like schools, health centres, etc. with electricity supply systems that fulfils their basic needs (either diesel generation sets or small PV systems). In a few villages, private entrepreneurs might be able to purchase diesel generators to provide themselves and maybe some neighbours with electricity. The barriers hindering the utilisation of wind energy at wind favourable sites will remain in place. Therefore wind energy will not be among the technologies used for rural electrification.

GEF Alternative. The GEF alternative is the implementation of wind stand alone and wind hybrid systems in Eritrea. By this means, wind energy technology will be considered as an equally fitting technical and economical solution in the overall Eritrean rural electrification planning in wind rich areas.

When determining the extent to which activities in component 3 are eligible for GEF financing, there are two notable aspects:

(1) Activities of component 3 are clearly “substitutional”(conversions) rather than “complementary”. This is due to the fact that component 3 activities mainly involve the installation and operation of pilot wind stand alone and wind hybrid systems. These systems will either substitute electrification with conventional small scale diesel systems or will meet the end user’s energy needs by offering him a viable replacement (e.g. electric light instead of using Kerosene lamps or cooking food without using wood-fuel).

(2) Such energy systems have not yet been introduced in Eritrea. Thus governmental institutions or private companies do not yet possess sufficient experience to implement and operate such systems in Eritrea. The ERTC is perhaps the sole entity which may at least have some basic information, including practical experience, with regard to wind and solar resource analysis, theoretical knowledge of wind energy technology and some practical experience in the installation and operation of PV systems. Successful implementation of wind energy applications in a sustainable manner in Eritrea for rural electrification purposes must have the support of both the government authorities and domestic private companies. It is, therefore, of ultimate importance that practical experience among individuals in Eritrea is developed. This can best be accomplished by installing such systems and then operating them. Such a real-life scenario will make it possible to achieve the establishment of the necessary institutions to sustain wind energy systems. This also would be an ideal exercise for creating procedures regarding procurement, approval, and certification for such a pilot project including its development and implementation. In addition, the project will gather actual feed-back from the real procured and installed systems for future rural wind energy projects. The results will be optimised designed system with reduced investment and O&M cost. The successful implementation and operation of pilot systems is of course necessary in attracting

and encouraging other local communities or private entities to begin efforts to install such systems, rather than only operating diesel generators for their power needs.

Component 3 remains therefore for the most part a barrier removal activity. The barrier is that of insufficient experience and lack of practical knowledge regarding the implementation and operation of small wind stand alone and wind hybrid systems for rural electrification. However, it is proposed that only 50% of the hardware costs will be covered by GEF funding.

The following table shows that the total costs of the GEF alternative are 0.951 Mil. US$. Of this, 0.62 Mil. US$ are GEF eligible. The GoE will cover 50% of the hardware investment costs. Of the total GEF eligible costs, around 0.27 Mil. US$ are for TA barrier removal activities, and around 0.32 Mil. US$ are for hardware costs.

Table: Incremental cost calculation, Demonstration Projects for Rural Electrification (component 3)

Incremental Cost Calculation				
Component 3: Demonstration Projects for Rural Electrification.				
	Baseline	***GEF Alternative***	***Increment***	***GEF Contribution***
	in US$	***in US$***	***in US$***	
Pilot Project Preparation				
Subtotal	**0**	**31.900**	**31.900**	**31.900**
Private sector analysis in Eritrea				
Subtotal	**0**	**24.400**	**24.400**	**24.400**
International tendering of the stand alone wind and wind hybrid systems				
Subtotal	**0**	**79.800**	**79.800**	**79.800**
Installation and commissioning of wind stand alone and wind hybrid systems				
Hardware Costs Pilot Projects, including transport, installation, spare parts				
Subtotal Hardware Costs	305.500	611.000	305.500	305.500
Local Tax on Equipment	0	24.440	24.440	0
Cost International Consultant	0	76.200	76.200	76.200
Cost National Consultant	0	20.000	20.000	20.000
Subtotal	**305.500**	**731.640**	**426.140**	**401.700**
O&M for a period of 1 year				
Subtotal	**30.550**	**54.950**	**24.400**	**24.400**
Analysis of the operation results after one year				
Subtotal	**0**	**28.400**	**28.400**	**28.400**
Total	**336.050**	**951.090**	**615.040**	**590.600**
5 % Contingencies				**29.530**
Total				**620.130**
Of the Total are Hardware Costs, incl. Contingencies:				**320.775**
Of the Total are for Barrier Removal and Technical Assistance, incl. Contingencies:				**299.355**

Global and Domestic Benefits. The following table provides with an overview of global and domestic benefits of the baseline and the alternative and the corresponding increment.

Table: Global and domestic benefits of the implementation of the decentralised hybrid system pilot project

	Baseline	**Alternative**	**Increment**
Global	GHG emissions associated with the provision of electricity by means of diesel generation sets.	Reduction of GHG emissions	150 – 200 tons/year of CO2 savings through pilot projects over lifetime. An order of magnitude more for replication potential in entire Eritrea
Domestic	NOx emissions	Reduction of NOx emissions	Not quantified
Domestic	CO emissions	Reduction of CO emission	Not quantified
Domestic	Lubricant consumption	Reduction of Lubricants	Not quantified
Domestic	Pollution due to used lubricant	Reduction of pollution	Not quantified
Domestic	high fuel consumption	Fuel savings	60 – 80 * 10^3 l of diesel oil savings over lifetime
Domestic	No demonstration	Demonstration of the technical feasibility and reliability of renewable based hybrid system for rural electrification in Eritrea Enabling the GoE and the local communities to consider such systems as a potential alternative instead of rural electrification via single diesel generation sets.	
Domestic	No economic development	Initiation of economic activities through availability of electricity	
Domestic	Migration from rural to urban	Reducing the potential migration from the rural villages to urban	
Domestic	No awareness regarding wind hybrid systems and few awareness regarding PV systems; no respectively few technical expertise regarding this technology in the rural villages available	Increasing awareness regarding this technology and creation of technical expertise regarding installation and operation of such system in rural villages	