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WIND ENERGY APPLICATIONS IN ERITREA

MID-TERM REVIEW

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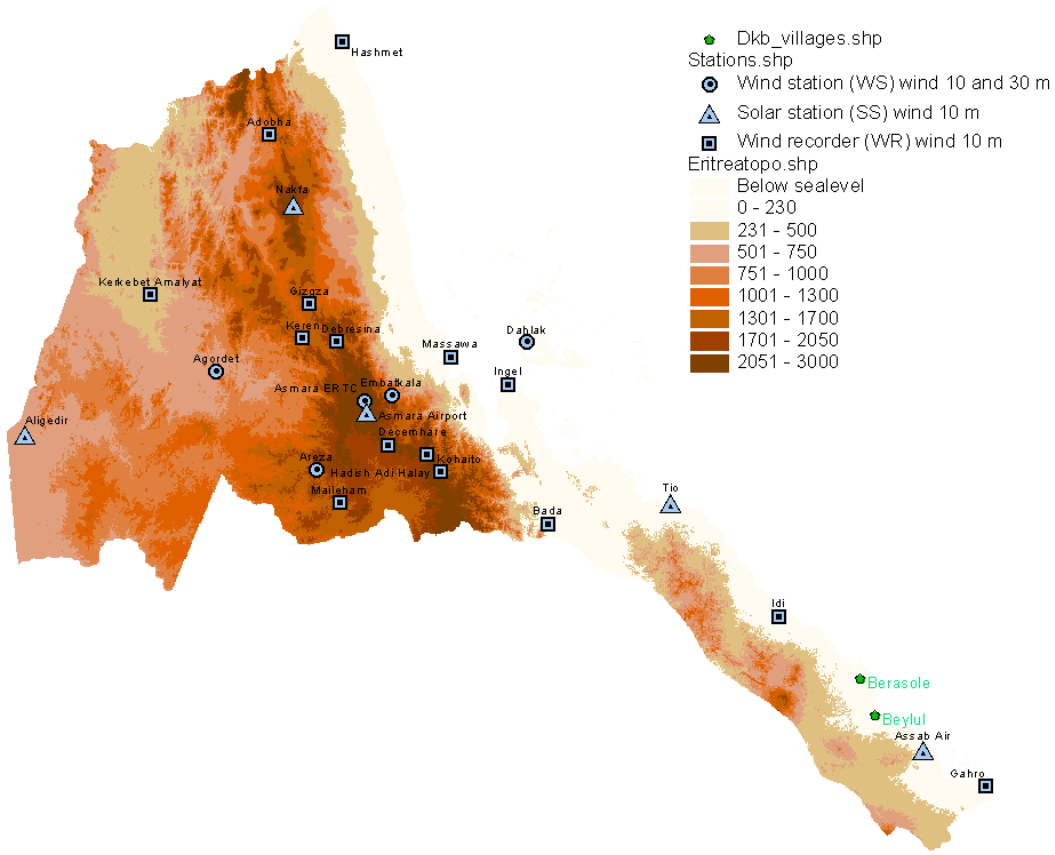

ERITREA: WIND AND SOLAR METERING STATIONS
Source: ERTC Wind Information System

LIST OF ABBREVIATIONS

AfDB	African Development Bank
APR	Annual Project Report (UNDP)
CDM	Carbon Development Mechanism
CO2	Carbon dioxide
DoE	Department of Energy, Ministry of Energy and Mines
EEC	Eritrea Electricity Corporation
ERTC	Energy Research and Training Centre
FAO	Food and Agricultural Organisation (UN)
FINESSE	AfDB Renewable Energy Programme
GEF	Global Environment Facility
GoE	Government of Eritrea
GWh	Gigawatt hour
ICB	International Competitive Bidding
ICS	Inter-connected System
IDA	International Development Association (the World Bank)
kV	kilovolt
kW/kWh	kilowatt/kilowatt hour
LCB	Local Competitive Bidding
LPG	Liquefied petroleum gas
MEM	Ministry of Energy and Mines
m/s	meters per second
MTR	Mid-term review
MW/MWh	megawatt/megawatt hour
N	nakfa
O&M	operations and maintenance
PCE	Petroleum Corporation of Eritrea
PDF-B	Project Development Framework B (GEF)
PIR	Project Implementation Report (UNDP)
PMU	Project Management Unit
PPA	Power Purchase Agreement
Prodoc	Project Document (GEF)
PV	photovoltaic (solar)
RE	renewable energy
SCS	Self Contained Systems
SIDA	Swedish International Development Agency
SME	small and medium enterprise
TA	Technical Advisor
TPR	Tri-partite Review
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Childrens Fund
USD	United States dollar (= nakfa 15.0)
W	watt
WIS	Wind Information System (ERTC)

EXECUTIVE SUMMARY

This Mid-term Review (MTR) aims at giving an independent view of the status, relevance and performance of the Wind Energy Applications Project in Eritrea and at identifying critical areas of improvement required for a successful completion of the piloting project. The project sponsored by the Global Environment Facility (GEF), United Nations Development Programme (UNDP) and the Government of Eritrea (GoE) is well beyond the half-point mark after three years of implementation and one year left for completion.

The project endeavors to introduce a new renewable energy mode new to Eritrea in launching pilot investments in both larger scale electricity generation into the national grids and in testing wind energy complementing diesel power or providing the sole electricity source in rural village communities, which do not have access to the two main grids. It also aims at transferring the wind energy technological and operating know-how to Eritrean institutions and players on the market, both at the central, regional and community levels through capacity building activities. Majority of the USD 4.1 million budget shared between GEF (47%), UNDP (41%) and GoE (12%) goes to the procurement and installation of a small wind park (600kW of output capacity) into the Assab grid in the South, and of eight small wind hybrid (with diesel power) and stand-alone systems into seven rural villages in the high wind regions, both in the South and in the Central Highlands. The former is operated by Eritrea Electricity Corporation (EEC) and the latter ones by the village communities. The project is to test through the pilot investments the technical, economic, environmental, social and institutional viability of these applications and to provide credible cases for their replication in Eritrea, and managing them down the line by local institutions and resources.

The project has been the victim of substantial delays due to protracted procurement and to the failed support to the Project Management Unit (PMU) from international wind energy specialist, whose contract was terminated half the way during implementation. The project has currently resumed full speed and is well in the way to complete the tasks by the completion extended by one year to June 2008. At the time of the MTR the Assab wind park installation was almost completed ready for commissioning (task 80% completed), the procurement for the decentralised systems was at final contract negotiation stage (task 50% completed) and the capacity building work had progressed to some extent (task 50% completed).

The investments are deemed well designed and technically properly prepared, especially the Assab wind park. The lack of on-site wind measurement data on three villages combined with the large seasonal and hourly variation in wind speeds may give some challenges to reach optimal generation levels and guarantee from the outset the economic viability of those investments. The technical and operations training efforts have lagged behind due to the non-performance by the international advisers and delayed delivery of the wind generating systems, especially to the villages, now expected only in March 2008 at the earliest.

The MTR assesses among the ***strengths*** of the project set-up and progress at this point of time the following:

- The project is well integrated into the GoE energy and power sector policies and priority investment programmes as one avenue of reducing dependence on imported fossil fuels in electricity generation;
- The PMU has been integrated in the Department of Energy structure and enjoys close co-operation not only from DoE, but also from the key players in view of operational results, Eritrea Electricity Corporation (EEC) and Energy Research and Training Centre (ERTC);
- The PMU staff is devoted in its job, has performed at a high professional level in pushing the project forward and has managed the complex international bidding and procurement process up to all standard and according to the required procurement guidelines and procedures. The PMU has managed it with a fraction of support expected from the international technical adviser (TA) team;
- The Assab wind park has been installed in a highly professional manner by EEC, the technology provider (Vergnet S.A) and the local contractors. The park is fully integrated into the Assab grid and distribution system and will be able to immediately complement the ailing diesel powered thermal plant, targeted to cover over 10 % of the annual output with the present capacity;
- Given (i) the presently high electricity tariffs in the Assab region, (ii) the financial limitations by EEC to run the system 24 hours a day, (iii) the limited levels of electricity that the households and

small business can afford to pay for and the hot climate, and (iv) the wind park with considerably lower operating costs than in the diesel plant (estimated to be 1/15 at the maximum and.1/ 4 at the minimum) the wind park has prospects to make the electricity more affordable to the poorest households, one of the main objectives of the project. The same potential affordability benefits apply to the villages, not having prior access to electricity, but soon receiving it through hybrid wind-diesel or stand-alone wind generation systems;

- The proactive and flexible support from UNDP in quickly stepping in to take charge of USD 1.4 million of the GoE budget contribution and an additional injection of USD 0.3 million to cover cost overruns, and *de facto* guaranteeing the project continuation.

A MTR has concluded few ***areas of concern***, which have hampered the progress and achievement of results:

- The failed and unfinished inputs from the Technical Advisor have caused delays in the project procurement and thus overall implementation. The project design had foreseen an unrealistically short time-table for the procurement of a major equipment component and had not secured intensive hands-on-support to the PMU. In addition, the selected TA team present in Eritrea apparently failed to have the operational wind park and international procurement experience, leaving PMU very much alone to carry out the complex task;
- In addition, the TA failed to assist PMU, EEC and ERTC in setting-up of a performance monitoring system for the Assab wind park and the decentralised systems, which should be based on practical operational and monitoring experience. This function is the key for the establishment of credible and "sellable" cases for potential replication of the applications, if found viable;
- The installation and roll-out plans for each pilot village have not been prepared and agreed upon with the village administrations and ERTC, the source for technical back-up support during the implementation. They should be initiated before the equipment arrives. The rules of the game are still open, including the cost-sharing requirements and arrangements. They should be harmonised with those of the Rural Electrification Programme principles to secure equal treatment to rural population within and outside the reach of the main grids;
- Much of the equipment specific training is being and will be given by the suppliers to the systems operators and maintenance staff. However, much of the systems operational, monitoring and maintenance training to eventual trainers at ERTC, DoE, EEC and the private sector is still to be initiated and arranged by PMU;
- A new TA contract should be in place urgently with an experiences wind systems operator to help PMU in establishing the monitoring systems, in launching the village roll-out and in arranging the operations training. The fastest way would be to invite the firm resulted in the second place (having received highest technical rating) to propose 2-3 wind park operations specialists to cover these functions, avoiding a lengthy re-bidding process;
- The awareness raising activities have been limited and should begin soonest;
- The bridging to eventual replication investments has not been built into the DoE plans. The project should be more efficiently utilised as the catalyst to raise the interest among the donors (The World Bank, EU, AfDB, bilateral donors, foundations), the private sector and stakeholders.

The key positive social impacts of the project includes potential for the Assab grid clients to have access to potentially cheaper electricity 24-hours- a-day through considerably lower wind power operating costs, and the reach of electricity and affordable wind power to rural villages. The economic impacts will enable EEC to operate on improved cost recovery basis, to boost the economic activity level among the households and small business. It is well conceivable that the impacts and the main operational objectives will be fully reached by the project by its completion.

As a general observation, the project has all the ingredients to establish good demonstration investment cases keeping in mind the considerations and reservations given above. Wind is a free, but capricious natural resource. The direction of the overall impacts will definitely be positive, but their extent and strength will be established only once the systems have been operating on the sites over a sufficient period, at least a year.

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1. INTRODUCTION

1.1. THE PROJECT

The project was conceived on the basis of the joint initiative in 2003 by GoE, UNDP and GEF to build upon the prior work done in Eritrea on research and opportunity studies on renewable energy utilisation, especially in solar PV systems, cooking stoves development, biomass utilisation and wind measurement. The project was designed and prepared under the "PDF-B" activity by German consultants (Lahmeyer International) hired by UNDP. The good wind potential discovered both in the Southern regions and in the central and Northern highland valleys have given rise to test the viability of wind power technology in the Eritrean circumstances. The project aims at transforming the market for wind energy applications in the country through demonstration and pilot investments in electricity generation both within and around the population centres and in rural villages. The main "drivers" have been:

- Introduction of a novel energy mode and technology to the country and the market players;
- Demonstration of the technical, economic, financial and institutional viability of both large and small wind energy applications through investments;
- Measuring the performance and drawing-up of conclusions on the replication potential of these applications;
- Giving models for wind power investments suitable for integration in the GoE rural electrification as well as for the grid based electricity generation;
- Lowering dependence on imported fossil fuels and reducing greenhouse gas emissions from the existing diesel generating facilities in Eritrea through their partial displacement by renewable energy sources;
- Helping the Government institutions, local communities and stakeholders in developing their know-how and capacities in planning, installing, operating, maintaining and monitoring wind energy systems.

The project has been built around three components:

1. ***Capacity building component:*** Development of personnel and institutional capacities in Eritrea to plan, install, operate and maintain on-grid and off-grid wind energy systems, and raising awareness among decision makers and players of the wind energy opportunities;
2. ***Assab Wind park pilot investment component:*** To install a pilot small wind park in the high wind area, connect it to the region's grid and test its performance and viability in view of potential capacity increase and replication wind parks elsewhere in Eritrea;
3. ***Decentralised small-scale wind systems pilot investments component:*** Installation of pilot wind stand-alone and hybrid applications in seven rural villages in order to test their viability and suitability for replication.

The initial project budget was USD 3.9 million, originally shared equally among GoE and GEF. Prior to that, USD 0.3 million was allocated by GEF for the preparatory work ("PDF-B"). During the implementation, UNDP took over the financing of USD 1.4 million out of the GoE share. UNDP injected another USD 0.3 million to the budget to cover cost-overruns in equipment procurement.

The Project Management Unit (PMU) with a staff of Project Manager, Professional Assistant, secretary and driver was to be established at ERTC, but was physically located within the DoE for operational reasons. International wind energy expertise was procured through a contract with an experienced operator and consultant for the three-year period. The integration of and active participation by ERTC, EEC and the regional and village administrations of the pilot sites as well as support from DoE in the day-to-day project work was considered essential for the success of the project. The project started its operations in August 2004 with a duration of three years. A one-year extension up to June 2008 was approved later on in order to accommodate the delays caused in the equipment procurement process.

The end result of the project was expected to (i) have the concerned institutions and staff properly trained on wind energy specific technology and operations, (ii) have the common awareness on the potential aroused among the relevant stakeholders, (iii) have the wind park and the eight applications installed and operated for some time, and (iv) have their performance and viability tested to prepare a credible basis for eventual replication programmes and projects.

1.2. PURPOSE AND METHODOLOGY OF THE MID-TERM REVIEW

The main objective of this evaluation is to provide the project partners i.e. GEF, UNDP & GoE with an independent review of the status, relevance and performance of the project as compared with the project document, identify and assess the basic results and impacts as to their sustainability and suitability for replication in other areas. The main tasks have been the following:

- Assessment of the project progress towards attaining its objectives and outcomes and recommend measures (if any);
- Investigation of the relevance of these objectives to the national development objectives and priorities, the UNDP/GEF areas of interest and the needs of beneficiaries. Hence recommend means of incorporating those priorities;
- Review of the appropriateness and clarity of the roles and responsibilities of stakeholders and the level of coordination between them;
- Review of the project concept and design with respect to the clarity of the addressed problems by the project and soundness of the approaches adopted by the project to solve these problems;
- Assessment of the performance of the project in terms of timeliness, quality, quantity and cost effectiveness of the activities undertaken including project procurement: both experts and equipment, training programs, etc;
- Review of the logical framework matrix and the indicators to assess their appropriateness for monitoring the project performance and to what extent they are being used by the project management;
- Assessment of the prospects of the sustainability of the project outcomes and benefits and recommend measures for its further improvement;
- Identification and description the main lessons learned from the project performance in terms of awareness raising, strengthening of technical and financial capacity, efforts to secure sustainability and approaches and methodologies used.

The review was carried out by the evaluator through the preparatory work at home office, a two weeks' mission to Eritrea and the analysis of the data and material and report writing at home office. The mission during August 11-25, 2007 consisted of interviews of the key stakeholders,

including the PMU, DoE, ERTC, EEC (both in Assab and Asmara), Southern Red Sea Administration, the Community Administrations at three villages, Eritrea Electrical Contractors' Association, the World Bank Resident Mission, the Delegation of the European Community and UNDP. In addition, a field visit was arranged by PMU and UNDP to the Assab wind park and three pilot villages (August 14-19) also interviewing the wind park technology supplier (Vergnet S.A.) installation staff in addition to the local stakeholders in Assab.

The review was made possible and greatly facilitated by the various partners in Eritrea. The evaluator would like to express his gratitude to the Ministry of Mines and Energy, the Department of Energy and the PMU staff, as well as the UNDP Country Office staff for their kind and efficient co-operation and assistance during the review process. Views and opinions expressed in this report are those of author and do not necessarily represent the official position of GoE or UNDP/GEF.

2. FINDINGS

2.1. OPERATING ENVIRONMENT

2.1.1. THE SECTOR AND SITES

The energy sector and generation in Eritrea are presently characterised by high share of biomass, and especially fuel wood, consumption, very low per capita electricity consumption (61 kWh in 2005) and low level of access (32% national level, 3% rural areas). The Eritrean Electricity Corporation (EEC), a recently corporatised state owned enterprise, is the sole public power utility in the country and runs two types of grid systems, the Inter-Connected System (ICS) around Asmara-Massawa regions and the Self-Contained System (SCS) around Assab and other parts of the country, such as Adi Keih, Barentu, Agordat and Tessenei. The total firm peak capacity of the two systems is 119MW (nominal 128MW), of which 10 MW in SCS. The electricity is generated from imported diesel and heavy fuel oil. The ICS has currently over-capacity with the commissioning of the Hirgigo 88 MW plant in 2002 currently run along with the Belesa Power Plant. The systems run at low efficiency due to aged generating equipment in most (except Hirgigo), lack of spare parts and maintenance, and high voltage drop in the distribution system.

The Assab diesel generating plant has an installed capacity of 8.3 MW (3.7 MW in production) with five smaller mobile units of 560 kW and two of 2.0 MW each. They are running only at 16 hours a day basis due to cost and maintenance reasons, meeting barely with the peak demand in the hot season of 4.5 MW and cold season of 1.7 MW. The generators are running in financial terms at a loss to EEC, as the operating costs (investment costs having been depreciated) exceed the income from the consumers. Most of the generators are approaching the end of their technical life-time, the smaller are due to be replaced within the next two years and the larger within five at the maximum. EEC has plans to acquire two sets of 2.5 MW heavy fuel oil generators in addition to the older ones. The site visit to the plant confirmed the evaluator the urgency for upgrading. The Assab thermal plant has a crucial role in the pilot wind park project. ***The wind energy does not only be beneficial by replacing fossil fuel fired generation, but also requires as an industry rule and absolute requirement in grid-connected wind power systems a 100% immediately available back-up generation source (such as diesel and hydro power). Therefore, a corresponding (min. 600 kW) capacity has to be readily available for the wind park in case of low wind speeds or failure at all times.*** Although the plant can offer such sufficient instant back-up capacity in the near future even in its current poor performance level, future investments are required into thermal capacity irrespective (and as a result of) of the potential expansion plans of the wind park.

The Southern Region used to be an active part of the coastal area due to the Assab export/import port in the past as well as the refinery. The former has lost its role after the border conflict with Ethiopia and the latter was also closed due to changed oil and oil refined products trade flows in the sub-region for the same reason. The region had been long neglected and has only recently been under concerted development efforts by the Southern Red Sea Administration and GoE, concentrating on roads, electrification, health services and education. The economic activities are concentrating on small business and fishing activities. New industries include a fish processing plant and a desalination plant with plans to develop tourism in the longer perspective. New villages are established as formerly nomadic population starts to settle down. This puts increasing pressure in providing them with facilities, including electricity. The households are still using moderate level of amenities and electrical appliances. The tariff rates, although subsidised by EEC due to the hot climate, are still very high for ordinary citizens to afford. Thus, the households while paying well for their electricity (EEC cost recovery rate is 80%) only add new appliances when they can afford to pay. Thus, there is a definite demand for cheaper electricity in the region, and suits well for the pilot wind park site.

The wind park site situated at an elevated location between the Assab airport and the port town of Assab. The site selection was based on wind measurements and deemed the most suitable one by PMU, ERTC and the TA during the early project implementation months. The average winds, based on ERTC measurements over the years indicate sufficiently high levels and speeds, but reflect high seasonal and daily variances. The winds have been on average 8-10 m/s during the hot season months and 5-7 m/s during the cold season. The daily maximum speeds in the afternoons have been between 12-13 m/s during the former and 6-8 during the latter. The level appears sufficient for commercial operation, but the high variance may pose some risk. The high peak demand in the afternoons, on the other hand corresponds to the wind speeds. Statistical data on Assab made available to the MTR by ERTC is presented in Annex 6 (Although the time series wind data provided is not very recent, it gives a good profile over several years of measurement).

The site is situated 4 km away from the connection point to the main grid, which would represent more or less the maximum commercially viable distance from grid for such a small operation. The fact that the connection will be made to allow for extension of the park capacity makes this distance less critical. (overhead costs 15% of the investment). The site terrain is very rocky and hard to work on, and has necessitated extraordinary measures in site preparation and excavation of the cable trenches and the foundations of the high voltage cabin. Cost overruns have been avoided though local contracts, but delays of several months were caused by the challenges due to the difficult terrain and hard soil/rock.

The seven villages for the eight decentralised pilot applications were originally made during the preparatory “PDF-B” phase, and were made to represent a variety of applications and, regions with high wind potential. One pre-selected village, Haleb, was recently proposed by PMU and the Regional Administration to be replaced by Idi or any other similar village with existing diesel generation facilities and sufficient wind resources. The selection of the former was based on the solid demand load expected from the village boat factory, which is not operating at the moment. Idi represents a dynamic growing village at mid-point of the highway between Assab and Massawa, and has a recently installed grid and a diesel generator system, and had a chance to provide a more representative case.

The reason for not including Solar-wind hybrid applications into the pilots has remained unclear to the evaluator. Even if the investment costs are higher compared with diesel-hybrid or stand-alone cases, the operating costs compared with maintenance considerations could speak in favour of such

units in some villages and for some uses. The vertical wind turbine alternative was dropped by PMU, as the technology has not been widely tested. This type of a pilot project should have tested such applications anyway, just to identify the conditions and limitations in operation, at least in one village.

Village	System	Capacity	Households	Purpose
Berasole	Wind-diesel hybrid	30 kW	108	Household electricity, ice-making, desalination
Rahaita	Wind-diesel hybrid	30 kW	117	Household electricity, services
Idi	Wind-diesel hybrid	30 kW	375	Household electricity, ice-making, services
Beilul	Wind stand-alone	10 kW	205	Household electricity, ice-making, services
Gizgiza	Wind stand-alone	10 kW	225	Household electricity, services
Gaharo	Wind stand alone	5 kW	99	Household electricity, services
	Wind (electrical)	3 kW		Water pumping
Dekemhare	Wind mechanical	3 kW	30	Water pumping

As far as the wind power sites are concerned, historical on-site wind data has been available from the metering stations at Gizgiza, Idi, Gaharo and Dekemhare villages. In addition, the project installed new stations at Gizgiza Pass and Haleb for data collection. No on-site data exists for Rahaita, Beilul and Berasole, but extrapolations have been made from the nearest measurement sites. Given the strong seasonal and hourly variation prevailing in wind speeds also in the windy regions, ***the lack of reliable data poses a certain risk*** to the project in terms of no absolute certainty on wind speeds sufficient enough for economically feasible level of generation to be achieved. The larger of the small units will have a diesel back-up generator, and thus does not jeopardise the uninterrupted service for ice-making, desalination plants and cooling equipment. The standalone systems would have battery storage facility to cover possible interruptions.
The wind data available at ERTC on the pilot villages is presented in Annex 6.

The MTR had a chance to pay a short visit in Beilul, Berasole and Idi. Some observations are presented below.

Beilul

- 205 households and population of 1,000 plus adjoining village of 35 households;
- Main livelihoods livestock, salt trade, fishing, palm weaving;
- No grid installed yet (promised by regional administration);
- Was subject to moving to a new site, was postponed due to floods;
- Households using kerosene oil lamps, 3-4 l/month per household;
- Water supply, clinic, schools exist
- Clinic has solar panel power, but is not maintained;
- Households could afford to pay N 20-25 per month for electricity
- Main use lamps, fans, TV, fridge
- Low level of awareness of wind project, no operational plans made.

Berasole

- 100 households;
- Fishing main livelihood, 35 boats;
- Main markets for fish in Assab and neighbouring areas;
- 25-50% of income goes to boat fuel;

- grid installed, but houses not yet connected;
- 2 x 120 kW diesel generators (one stand-by) installed, but not operational;
- Installation took 35 days;
- Done by regional administration and EEC, no payment asked yet;
- Ice-making and desalination units installed by Ministry of Fisheries/FAO/AfDB project for free;
- Households can afford to pay N 50 per month for electricity;
- Mainly to replace kerosene lamps and introduce fans;
- Awareness level low on wind project (except for bidders' visit).

Idi

- 375 households, population 1200;
- Established due to highway transit, grown rapidly during last 3-4 years;
- Main livelihoods fishing, trade and highway services;
- Wind recorder since 2000;
- Village grid installed 7 months ago, houses not yet connected;
- Ice-making unit installed (no desalination) by FAO;
- No payment requested yet by EEC, nor informed, ready to pay;
- Main household use lamps and fans, some in electric stoves.

The discussions in the villages brought in limelight four issues: a) the installation of the grids has been a top-down directed activity with little participation by the villages; b) the level of information on that installation, and ownership by the villages is not there yet; c) the cost recovery and other operational issues are wide open, and have not been even discussed with the village administrations; ***d) the same approach seems to have taken with this wind project as the awareness level is almost non-existent. This presents a major risk for running the pilots efficiently, and getting the performance results and making most of the short time available between March-June (December?) 2008.***

2.2.2. POLICIES AND PROGRAMMES

The development of alternative and indigenous renewable energy sources and modes has long been the corner stone in the GoE Energy Policy and Strategies. The most recent policy sets the primary objective as: *"to avail ample, dependable and sustainable energy for the growing needs of all sectors in Eritrea at an affordable price"*[1]. Emphasis is not only on the adequacy and affordability of energy, but also the qualitative aspects including flexibility, efficiency, environmental sustainability and usage convenience. The issues of social equity, quality of service, energy conservation, environmental protection and safety are critical. So is the issue of ensuring energy security, as the country is heavily dependent on imported fuels. The development of petroleum and electricity sectors is the main focus area. The goals signify major investment in additional capacity in electricity generation, improvement in energy efficiency in the existing infrastructure and improvement of the sector management.

[1] The section is based on: Ministry of Energy and Mines: Revised Energy Policies and Strategies (2007) and Energy sector reform in Eritrea: initiatives and implications (DoE, University of Asmara 2005 article)

The policy will be implemented in eight distinct priority areas:

1. Energy reform measures: Develop the regulatory framework to attract private sector participation; to restructure EEC to become financially self-sustaining, strengthen the Petroleum Corporation of Eritrea.
*2. Investment promotion: S*tate will continue to remove barriers for private sector participation; intensified efforts in attracting international financing for investment programmes; indigenous energy resources exploration; attraction of foreign investment in oil refining and transit storage facilities.
3. Improve sector management capacity: Improve the capacity and performance of the institutions in overall planning and management; enhance data collection and audit systems; improve co-ordination; strengthen the Ministry of Energy and Mines.
4. Implement "right pricing" policy: The pricing should reflect true economic opportunity costs, correct market failures to make energy accessible to all and especially the poor, control energy consumption, promote energy efficiency and conservation; heavy fuel oil and kerosene import duty exemption should be continued, tax benefits introduced to the importation of equipment for renewable energy production; LPG supply system expanded.
5. Promote energy conservation and environmental protection at supply and end-user levels: Introduction of new technology and appliances, consider concessionary taxation policies for energy efficient appliances; incentives for forestation; public awareness campaigns.
6. Promote rural electrification: Give higher priority to give access to rural poor; participate in initial investment costs; create revolving Rural Electrification Fund to co-finance investments; develop transparent guidelines to select appropriate technologies and to prioritize; promote ownership and responsibility among communities; establish micro-finance schemes; link electrification to income generating activities in agriculture, fishery and education, health services etc.
7. Promote regional co-operation in energy trade: Consider increased regional co-operation in power systems inter-connection schemes.
8. Keep abreast with modern technology developments: Enhance research and development and investment in state-of-the art modern technologies, especially renewable energy, including wind energy.

The current short and medium-term energy sector investment programme[2] consists of diversified investments in refurbishing and expanding the existing generating plants, in expanding the Rural Electrification Programme and supporting greenfield investments in renewable energy, including major wind, solar and geothermal power applications.

The present economic situation in the post-conflict phase and that at least in the near future implies that investments in the energy sector have to be financed on a grant basis. The Rural Electrification Programme has been supported by SIDA of Sweden during two first phases and the World Bank during the current third phase in the form of grants cost-sharing the extension of the grid to new villages. The ICS grid reinforcement investments are also covered through a soft IDA loan under the World Bank umbrella assistance to the sector. Given the negative operating margins of the Assab diesel generating plant, the badly needed and planned replacement of generators and the increase of peak capacity have to be largely covered through external concessionary financing, either through soft loans or outright grants.

[2] DoE is currently in the process of finalising the details.

Wind power investments enjoy public subsidies world-wide either in terms of investment grants (25-40%) or through corresponding producer pricing subsidies or tax benefits, as the economics of wind power generation cannot work in the open electricity markets without such financial injection. The Eritrea energy policies include the consideration of incentives to the renewable energy production, and should prepare for such fiscal instruments. However, the proper investments are still expected to enjoy further grant support from outside donor sources in the near future. A feasibility study has been made by German technology supplier in Dekemhare on a 6 MW wind farm. The investment has been appraised as commercially viable with the wind availability and the current price level (7 US cents producer price/kWh), but genuine investors and risk and commercial financing are not available due to the high political risk situation and unbecoming enabling environment for foreign investors. The case proves that this is the present state of the affairs with regard to foreign investors in wind power. GoE should take definite and concrete steps to make such investments more attractive and with reasonable returns on the investments. Solid foreign investors normally bring along their own financing or access to new financing sources and instruments, such as equity and "mezzanine" financing (e.g. subordinated lending, partial risk guarantees).

Assessment: The project fits in well and is an integral part of the GoE energy policies and investment programmes. Successful implementation and positive results in actual performance of both systems would greatly facilitate the implementation of the GoE policies and investment programmes.

2.2. PROGRESS MADE TOWARDS OBJECTIVES

In general terms, the project has had its "ups and downs", the implementation was started well in a dynamic fashion on all fronts, experienced serious delays due to non-performance by the Technical Advisor (TA) and the injection of additional financing by UNDP to the project. The thrust of the activities, procurement of wind technology, has been considerably delayed, but has been conducted by PMU according to all acceptable guidelines and standards. The investments are at near-commissioning stage for the wind park component and supply contract stage for the decentralised systems component. The project has been able to regain its intended pace and is presently progressing well. The PMU has performed in a commendably efficient, dedicated and professional manner, and has with the support from DoE, EEC and ERTC been able to launch the investments despite limited support from international wind energy specialists.

The chapter below analyses in more detail the project success and progress so far in terms of the objectives, outputs and activities spelled out in the *Prodoc* and is presented by the three main components. The presentation has been made in "bullet points" to keep it short.

2.2.1. PROJECT COMPONENTS

COMPONENT 1: CAPACITY BUILDING AND AWARENESS CREATION

The capacity building component has been included as the means of helping overcome the existing experience barriers in successfully introducing wind energy both into the grid and non-grid systems. It also aims at lowering institutional barriers by improving the know-how base within the local concerned institutions (DoE, ERTC, EEC) and by introducing appropriate processes and procedures. In addition, the component has been designed to remove technical barriers within and outside the grid operations through training.

***"Immediate Objective :** 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 community and central levels."*

***Assessment:** The capacity building activities have been covered only partly and have been concentrating on general familiarisation to wind energy technologie.Training into specifics on installation, O&M and other technical aspects as well as on practical planning and preparation of new wind energy investments has not yet taken place. Much of the overall planning and support was intended for the TA, which did not materialise especially with regard to on-the-job training. PMU has to take pro-active and immediate steps in preparing and implementing the missing training programmes and events with the support from the new TA contract. There is a major danger to lose much of the catalytic effort and impact of the project to local knowledge and capacities to develop future investments and maintain the existing ones. Given the relatively short time remaining the overall targets are realistically expected to be reached no higher than 70 per cent level. (Delivery level 50%; less than satisfactory)*

The progress made under this component and the remaining tasks are reviewed below in connection with each output and activity and are summarised in Table 2.1.

(Output) 1.1 Grid connected wind park training

(Activity) 1.1.1. Technical and managerial seminars for EEC staff in Assab and Asmara
Delivered:

- The wind park technology provider (Vergnet S.A.) has started with technical training for EEC operators at site during park installation;
- Project Manager,ERTC and EEC staff received training at factory in France;
- Project management training (2.5 days) by TA team to PMU, DoE, ERTC, EEC in Asmara;
- Renewable energy project planning and analysis software (PROFORM) training (2 days) by TA team to PMU, DoE, ERTC and PCE in Asmara (16 participants).

Planned:

- Technical training for EEC and DoE at site by Vergnet (20 persons).

Assessment: Vergnet will be covering their share sufficiently also having full set of operations and maintenance manuals in place in Assab. The project management and analysis training for the key agencies was considered useful by PMU. Evaluator considers this training useful as generic support. The formal and on-the-job training in procurement and tariff systems for EEC in Assab and Asmara was allocated to TA , has not taken place and should be included in the new TA contract. Practical training how to plan and prepare future wind energy projects should be included to fill the obvious gap due to the deficient Concept Papers prepared by TA.

1.1.2. Training for EEC and DoE in supervision and acceptance of civil, electrical and mechanical works.
Delivered:

- None

Planned:

- Was originally foreseen just before installation of the Assab park, is currently not in plans.

Assessment: The acute training need has passed, but may be required for the decentralised systems component, and should be considered by PMU (new TA contract).

1.1.3. Wind technology study tour abroad.
Delivered:

- Two week study tour in USA for PMU, DoE, ERTC, EEC senior management and UNDP, Asmara was organised by TA introducing to wind technology and research and operational wind park (5 persons).

Assessment: The study tour was considered useful by PMU and was well arranged. A necessary eye-opener to the main stakeholders. No further training required.

1.1.4. Masters-level fellowship training abroad for one person (Prodoc 2 persons).
Delivered:

- Suitable person and study venue were selected by PMU and TA, but were disallowed due to GoE regulations and current policy.

Assessment: The cancellation of this training will hamper the overall and long-term impact of the project in its ability to introduce new energy technology to the country in a sustainable fashion.

1.1.5. Cross-training of local experts in on- and off-grid systems.
Delivered:

- None

Planned:

- Planned activity, but no specific plans at PMU.

Assessment: The training would be very useful in view of getting prepared for the replication phases. PMU and ERTC should prepare training plans (support from new TA contract).

1.2. Strengthening of ERTC to become national centre of competence in wind energy technology

1.2.1. establish PMU in ERTC
Delivered:

- PMU was properly established at project start-up within DoE.

Assessment: The positioning of the PMU within DoE proper was a good choice and provided it with the better operational links e.g. with EEC, the park operator. The PMU should have received intensive on-the job training and guidance especially in international procurement, insufficientlt covered by the TA.

1.2.2. Training of trainers under ERTC for public and private sector experts.
Delivered:

- None

Planned:

- Training planned under the other training programmes of ERTC.

Assessment: This is one of the key training tasks to be carried out by the TA team, but was not delivered. The catalytic effect from this type of training is essential for the replication stage of wind power generation, and much will be missed without it. The eventual target audience would be the

village communities and line ministries involved in related programmes. PMU should include this in the imminent work plan with ERTC (support from new TA contract).

1.2.3. Develop a renewable energy data bank at ERTC.
Delivered:

- None

Planned:

- No definite plans at PMU

Assessment: The existing Wind Information System (WIS) was supposed to be further developed into a wider RE data bank with support from TA. ERTC continues to develop WIS and its own RE data storage and library. Further support from the new TA contract should be also channelled to this activity.

1.3. Training of engineers, technicians and electricians in the private sector to service future projects.
Delivered:

- Representatives from the Eritrea Electric Contractors Association participated in the Inception Seminar;
- No further training has taken place.

Planned:

- Seminar(s) for the Association members on installation and O&M;
- Training of trainers to take over the tasks.

Assessment: Although a relatively limited number of engineers and technicians would be involved in wind power installations, they have to be able to maintain the equipment. The private sector is expected to play a growing role in the installation and O&M business also in wind energy applications. Thus this training is justified and necessary.

1.4. Raising awareness of wind energy potential and role

1.4.1. Awareness campaigns to community leaders
Delivered:

- Only initial information has been shared with the pilot community administration

Planned:

- Structured work plans coupled with information dissemination in target villages;
- Once first results available, spread of information to other potential targets.

Assessment: The level of awareness in the three villages visited by the evaluator was very low, almost non-existent. PMU and ERTC should step up activities immediately in the villages and start with the installation work plans and negotiating modalities in roll-out.

1.4.2. Awareness campaigns to leaders in private and public sector at central level
Delivered:

- None, with the exception of the Inception Seminar.

Planned:

- Campaigns planned once the technology is in place and operational.

Assessment: PMU standpoint of not acting before the action is in place is partly understood. However, a more pro-active approach should be adopted to start preparing for the eventual replication of wind technology utilisation. This audience is the key in the next phases. Support from the new TA contract could be made available also to this activity.

1.4.3. Awareness campaigns for the general public

Delivered:

- None as specific activity, a few articles and news clips have appeared.

Planned:

- Publicity when park starts operations and when pilot villages covered.

Assessment: The comments made above also apply to this activity.

TABLE 2.1.: PRESENT DELIVERY STATUS AND PLANNED CAPACITY BUILDING ACTIVITIES

Output/Activity	Provided by	Targets	Pro doc No.	Compeleted No. of targ. pers. %		Planned add. No. of targ. pers. %		Comments
1.1. Grid connected wind park training								
1.1.1. Seminars/on-the-job								
Technical	Vergnet	EEC/elect/mech	n.a.	5	20	20	100	On-the-job trg. currently underway
Managerial	Consultants	EEC/mid-mgmt	n.a.	-	-	8-15	70-100	Eritrea or abroad depending on budget
1.1.2. Supervision, works	Consultants	EEC /techn.	n.a.	-	-	6	70-100	
		DoE	n.a.	-	-	3	70-100	
1.1.3. Study tour abroad	TA	DoE,EEC, ERTC sr.mgmt	n.a.	4	100	-	100	Completed
1.1.4. Masters trg abroad	For.university	Undergraduate	1	-	-	-	-	Cancelled
1.1.5. Cross-training in sites	EEC,ERTC	New sites	n.a.	-	-	n.a.	n.a.	Depends on actual demand
1.2. ERTC strengthening								
1.2.1. Est. of PMU	Project	DoE/ERTC	2+2	2+2	100	-	-	Established at DoE
1.2.2. Specific training	ERTC	Stakeholders	n.a.	-	-	6-10	70-100	Additional to ERTC other related training activity.
1.3. Private sector players								Depends on activity of contractors.
1.3.1. Electric contractors trg.	ERTC,EEC	Contractors	n.a.	-	-	40-60	70-100	
1.4. Awareness creation								
1.4.1. Campaigns with communities	ERTC,DoE	Comm.leaders	n.a.	7	100	20-30	+	Depends on No of new sites added
1.4.2. Public and private sectors, central level	TA, DoE	Leaders, stakeholders	n.a.	yes		yes		Ongoing and continuing activity
1.4.3. General awareness	DoE,ERTC	General public	n.a.	yes	10	yes	100	More once wind park and pilots operational.

COMPONENT 2: INSTALLATION OF THE ASSAB WIND FARM

"Immediate Objective: 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 technically, financially and institutionally feasible and can be a least-cost supply possibility in Eritrea at high wind speed sites."
Assessment: The wind park nominal and operational capacity has been tailored to the Assab grid and existing generating system, resulting in rated capacity of 600 kW, somewhat lower than the originally planned capacity of 750 kW. The targeted minimum production (2,500 MWh per annum) would, however, surpass the originally planned output level. Despite the delays e.g. in excavation of the difficult rocky terrain PMU and EEC have performed well and in a professional fashion. All the necessary physical preparations for such a pilot wind park operation have been properly carried out. Technical training as well as setting up of the performance monitoring system will still have to be initiated by PMU and EEC. (Delivery level: 80%, satisfactory)

(Output) 2.1. Contractual framework for the first wind park

(Activity) 2.1.1. Contractual arrangements for the wind park until financial closure
Delivered:

- All necessary contracts are in place.

Assessment: The bidding and contracting process took longer than expected manly due to the insufficient technical and operational support from TA and lack of prior experience by PMU on similar international procurement.

2.1.2. Prepare model contracts for power purchase and wheeling agreements for grid-connected RE projects
Delivered:

- TA has submitted a generic model Power Purchase Agreement (PPA), based on a wind park operation in Colorado, USA.

Assessment: The PPA draft was presented by TA with a substantial delay without giving any hands-on training support. The usefulness in practice of the agreement seems to be in serious doubt as the text was obviously copied almost word-by-word from a wind park project PPA in Colorado, USA, without any apparent attempts to adapt the text to Eritrean circumstances and legislation. The necessary in-depth consultation process during the preparation and submission was totally missing. As EEC will operate the Assab wind park, no PPA is required in the first place. The present model should be reviewed by local lawyers and power specialists and adapted accordingly, before it can be used for any forthcoming potential Independent Wind Power Producer PPA's. DoE and EEC have already taken action to formulate a PPA for the Assab wind park. Thus no further support is immediately required.

2.1.3. Prepare tender documents, provide support to tender process and give on-the-job training
Delivered:

- The tendering process has been successfully completed concerning the equipment supply, installation, civil works and the grid connection.

Assessment: Majority of the work has to be undertaken in isolation by PMU basing the process, quite rightly, in accordance with the World Bank procurement guidelines. Technical support from TA was inadequate, resulted in unnecessary delays in finalisation of the bidding documents and process. In addition TA was unable to perform e.g. of the grid reinforcement design specifications, later prepared by EEC. No training was either given to PMU and EEC staff. PMU thus managed to go through this very key task and function in a commendable and highly professional manner.

2.2. Install a 750kW wind park in Assab and connect it to the grid.

2.2.1. Formulate an optimal operation strategy for the wind park

Delivered:

- Configuration and size confirmed by PMU and EEC.

Planned:

- EEC to integrate and operate the wind park according to the Assab grid operation strategies, once commissioned.

Assessment: As EEC will be the wind park operator, the operations strategy will have to be integrated in the company's power generation system and plans within the Assab grid. The plans are ready to be tested and the park is to be connected via the main switchboard into the system.

2.2.2. Disseminate operation results to attract further investments

Delivered:

- None, as park not yet in operation.

Planned:

- Will be based on the outputs of performance monitoring.

2.2.3. Procure and install the grid connection cable and the wind park substation

Delivered:

- Work is underway and will be completed shortly.

Planned:

- The park will be connected to the grid by a provisional overhead cable to enable earlier commissioning;
- The proper connection cable is currently being installed and will be completed before October 2007.

2.2.4. Reinforce the Assab grid prior to park connection (incl. 3 cabins)

Delivered:

- Carried out by EEC.

2.2.5. Install the park consisting of three 250 kW turbines

Delivered:

- The park is 95% completed with three 275 kW turbines (with adjusted rated capacity of 600 kW).

Planned:

- Commissioning and testing in September 2007;
- Starting to supply electricity to the grid in October 2007.

Assessment: The installation work is almost finished and has been performed in a highly professional manner despite the delays caused by the difficult terrain and hard soil. Vergnet has performed according to expectations, has replaced on its own account three "noisy" gearboxes and is committed to continue with the training and technical support as per the contract. EEC has also taken its responsibilities seriously, and appears very committed to the operator's role and functions, and has already integrated the forthcoming wind power into the main grid system and plans.

2.2.6. Operate wind park and evaluate performance

Delivered:

- Not yet operational.

Planned:

- Operations ready to start in October;
- Technical training of EEC park operating and maintenance staff will continue by supplier for two months;
- Performance monitoring system in place at start-up.

Assessment: EEC is committed to take over the responsibility after commissioning. The performance monitoring system for the wind park is not yet in place. It is essential for PMU and EEC to take immediate action in designing the methodology, benchmarks and indicators to help to bring out the case for potential replication investments. Without proof of the technical and financial performance of the wind park such interest is hard to find. The new TA contract could bring along at short notice the necessary international wind park operations experience needed in this task.

COMPONENT 3: INSTALLATION OF EIGHT SMALL-SCALE DECENTRALISED SYSTEMS IN RURAL VILLAGES

***"Immediate Objective:** 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-economical viability."*

***Assessment:** The procurement process is still underway at final stages and was delayed due to poor performance of TA in helping prepare specifications and bid documents, cost overruns in lowest evaluated bid price (and all bid prices) and due to the rejection of the winning bid. Four sizes and types of turbines and varied end uses have also necessitated the sourcing of the equipment supply from a number of manufacturers, also slowing down the procurement process and bringing up the total price of the package. The installation work plans are still at a very early stage at the community level and require quick action from PMU and ERTC (the responsible GoE agency to install and maintain the systems). Quick action is required to prepare the villages and their administration for the roll-out phase. Two villages (Beilul and Gizgiza) still require the village local grid to be erected. PMU should make all efforts in expediting the delivery and installation of the systems, can be completed, tested and monitored by the present project completion of June 2008(or end 2008, if further extension is granted). The performance monitoring and the establishment of the viability of the applications require a period of minimum 6 months to one year for the on-site monitoring work. Technical training of the village responsible technicians/electricians is still to be commenced and should start soonest, as well as the organisation of the networking support within ERTC. The equipment related training by supplier should be complemented by operations and performance monitoring support by the new TA contract, at least in critical issues. (Delivery level 50%; satisfactory)*

3.1. Procedures in place between local ,regional and central administration levels and across line ministries for identification, implementation and operation of rural wind energy projects.

3.1.1 Analyse existing procedures including delegation of responsibilities.
Delivered:

- experience gained within DoE and ERTC on rural electrification and RE (especially solar) programmes;
- no specific analysis made by TA or PMU.

Planned:

- roll-out when equipment arrives.

Assessment: PMU appears to piggy-back on the rural electrification procedures and work initiated by Regional Administrations in providing closed diesel powered grids to selected villages. The evaluator considers it essential to do the foot-work as soon as possible in each pilot village to clarify the work programmes, responsibilities and operational modalities, including cost recovery and tariff issues. The training (see also component 1) should be initiated before the equipment arrives.

3.1.2. Test the procedures in selected villages and production sites.
Delivered:

- not done yet.

Planned:

- plans, but no structured work plans exist at PMU and ERTC.

Assessment: As in 3.1.1.

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

3.2.1. Identify financing options successfully applied in other countries and associated lessons learned.
Delivered:

- TA has prepared a generic Project Finance Manual.

Planned:

- no specific plans exist, as TA failed to fully perform the task.

Assessment: The Project Finance Manual has limited value for DoE or other stakeholders for the identification of suitable financing sources and instruments to be used in decentralised investments. It is an academic and superficial overview of methodologies and not a practical guide to financing as developers and promoters would like to see it. No lessons learned e.g. in SME lending experiences, partial risk guarantees, revolving funds, ”smart subsidies” or other widely used financing methods were covered. The CDM financing section is hardly relevant to smaller wind applications (often even larger ones) or the Eritrean circumstances. In the present Eritrean circumstances, however, it is realistic to presume that the investment costs will be fully or substantially covered by donor and GoE grant financing programmes, and only operating and maintenance costs would be covered by the villages. Therefore, this task is not considered as urgent today as the other ones.

3.2.2. Test the most promising financing models (e.g. micro-finance, soft loans etc.).
Delivered:

- TA was unable to carry out the task.

Planned:

- PMU has no specific further plans, as TA failed to deliver.

Assessment: As stated above, the task appears to be less urgent at the present stage, as grants will predominate as the main realistic financing source today. Micro-financing can solve small working capital problems, but not to finance investments. The financial market in Eritrea is still too shallow and undeveloped to consider sophisticated financing and risk instruments to be used for the time being. However, the project should lay the foundations to initiate action to solve the imminent financing challenges in the replication phases of such schemes, as GoE financing resources will be limited.

3.3. Five diesel-wind hybrid and three stand-alone systems installed

3.3.1. Prepare, tender and commission the eight pilot projects
Delivered:

- PMU has carried out the tendering process up to late contract negotiations stage (contract was signed after the MTR mission in early September 2007).

Planned:

- Expediting the delivery of equipment.

Assessment: PMU has carried out the procurement process with only limited support from the TA team and has performed well. The village-based installation and work plans should be urgently initiated by PMU and ERTC to prepare for the roll-out.

3.3.2. Install the eight pilot projects.
Delivered:

- Not done yet.

Planned:

- Installation will take place earliest after April 2008, when delivery of equipment is expected to take place.

Assessment: The comments above on preparatory work also apply here. ERTC has been assigned to take the lead and main responsibility in the installation together with the suppliers, as it will also be taking care of the after-delivery service and maintenance functions, which the villages cannot perform themselves. The basic organisation appears to be in place.

3.3.3. Operate and maintain the systems
Delivered:

- Not done yet.

Planned:

- The villages and designated technicians/electricians will assume the day-to-day responsibility for O&M and ERTC will provide the back-up service in addition to the warranty cover by the manufacturers.

Assessment: The operating principles appear realistic, but details have still to be worked out among the villages, ERTC and PMU well in advance of the installation phase. The equipment specific technical training as well as more general wind power systems operations and maintenance training to key ERTC staff is still required (equipment suppliers, PMU with support from new TA contract).

3.3.4. Analyse and disseminate operation results after 1 year of operation and in subsequent years.
Delivered:

- Not done yet.

Planned:

- Will be done as part of the performance monitoring system.

Assessment: A solid monitoring framework has to be established to help fulfil the immediate objective of ensuring the technical, financial, institutional and socio-economical viability of the pilot applications. The new TA contract would help design these benchmarks, which are vital for any credible replication to take place and for securing outside financial support. The project completion date has to be extended at least until end 2008 to enable sufficient monitoring to take place. Dissemination of the results would be possible only at the very end of this period.

2.2.2. LOGICAL FRAMEWORK REVIEW

The MTR was also to comment on the logical framework matrix presented in the Prodoc, in view of comments on the relevance and applicability of the original indicators developed therein. The indicators and performance targets on both the wind park and the decentralised system should be defined when the performance monitoring system (still missing) will be designed. The MTR comments are presented in bolded red italics after each relevant section when applicable.

Table 2.2.

PROJECT PLANNING MATRIX

STRATEGY	INDICATORS	MEANS OF VERIFICATION	CRITICAL ASSUMPTIONS
Global Environment 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) ***Mid-term Review Comments: Objective still valid.***	Yearly consumption of diesel used for the Assab grid reduced by 682,000 liter/year ***Indicators are measurable and valid.*** ***No operating data available yet*** ***Current annual consumption level is 6.9 million litres. Target is reachable with the estimated generation of 2.1 GWh replacing 720,000 litres of diesel p.a.*** Yearly consumption of diesel used in the villages where a wind-diesel hybrid system has been installed reduced by 6000-8000 liter/year ***No operating data available yet. Diesel back up capaclty introduced almost simultaneously***	EEA statistics ***(EEC local diesel figures, PMU wind, energy yield calculations)*** Community administration statistics	Diesel and kerosene prices will not drop more than 30% as compared to average 2003 prices
Development Objective: To promote socio-economic development and improve people's livelihood by facilitating access and affordability to modern, clean energy services ***Still valid***	Generation costs of electricity reduced by 30% at the Assab grid and the off-grid sites. ***No operating data available yet.*** ***Target reachable.***	EEA statistics and community administration statistics	There will not be a new war between Ethiopia and Eritrea
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 ***Still valid***	Amount of money spent on international wind energy experts and consultants reduced by 50% per kW installed capacity for new wind energy initiatives in Eritrea as compared to the baseline year 2003 ***No new initiatives in place yet. Indicator hard to measure. Initiatives can be also private. Better e.g.: amount of grant supported capacity training to EEC, DoE and ERTC reduced to half in USD terms p.a.***	Budgets of new wind initiatives	The necessary staff resources inside ERTC, EEA and DoE will be available and motivated to provide the necessary services to governmental authorities, local communities and other partners ***Sufficient resources in place.*** Staff turnover will be reduced and qualified staff can be attracted and retained
Output 1.1: The necessary skills within the utility (EEA) for grid connected wind park planning, installation, operation and	EEA takes the lead on expansion of the Assab wind park or any other new wind park ***EEC is in charge of phase I. Extension not yet***	Planning docs and contracts of new wind park	Staff turnover will be reduced and qualified staff can be attracted and retained

maintenance developed ***Still valid***	***timely. One early grid-related proposal has been developed with EEC/DoE.*** The Operation and Maintenance LogBook of the Assab wind park shows that the park is running smoothly within international parameters ***Not yet available***	initiatives O&M LogBook	
Output 1.2: ERTC strengthened so that it can take the position of a national centre of competence for wind energy technology ***Still valid***	ERTC has the budget, human capacity and vision documented in an institutional strategy to operate wind energy systems in Eritrea ***Only qualitative indicators possible, as project can have only limited impacts.*** ***No. of staff in day-to-day village wind systems support.***	ERTC files	GoE has the budget and political will to strengthen ERTC
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 (off- and on-grid) ***Still valid***	70% of all technical training courses offered to electricians, technicians, engineers etc. are carried out successfully ***EEC and ERTC are using private contractors for installation, O&M or have certified them***	Project files	
Output 1.4: Awareness about the viability of wind energy amongst decision makers at all levels (including communities) and the general public increased	80% of all community leaders in wind rich villages know about the advantages of wind energy systems by the end of the project ***Still valid***	Survey	
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.	Assab Wind Park is up and running and operating smoothly as per international standards by end of year 2 of the project with a capacity factor of 44 +/- 5% ***Start-up delayed by 15 months (September 2007), by end of project (mid- or late 2008)*** At least one additional wind park or extension of the existing wind park is at the stage of financial closure by the end of the project ***Assab extension is actively planned for. EEC has considered, carried out feasibility studies on wind applications in ICS grid(GizGiza, Dekemhare).***	EEA files	Electricity demand will increase over the coming years
Output 2.1: Necessary contractual framework, including model PPA and wheeling agreement, for a first wind park connected to the Assab grid prepared	Assab Wind Park is up and running by end of year 2 of the project ***Delayed by 15 months. No PPA needed as operator and buyer are the same.*** Future wind parks are using the model PPA and	Site inspection Contracts of future projects	

	wheeling agreement ***Draft PPA prepared, not used yet, needs amendments. May happen way after the project completion.***		
Output 2.2: A small wind park in Assab connected to the grid having a capacity of 750 kW installed and in operation	Assab Wind Park is up and running by end of year 2 of the project ***Delayed by 15 months. Capacity will be down-rated to 600 kW. Production targets could also be set: i.e. running at 90% availability year 1, 95 % year 2; running at minimum 38-43% capacity factor average; minimum production target 2.2-2.5 MWh year***	Site inspection ***As estimated by PMU***	
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	Kerosene fuel use for lighting in pilot villages reduced by 50% by end of the project ***Not materialised yet. Valid and measurable.*** 80% of the electricity end users are satisfied and can afford the electricity offered ***Not applicable yet. Many can only afford basic use of electricity at start.*** ***More operational targets such as: ratio for wind/diesel generation 40/60 at project completion (to be defined within performance monitoring system)***	Medical statistics and reports End-user survey	Kerosene prices will not drop more than 30% as compared to average 2003 prices
Output 3.1: Procedures, which allow the identification, implementation and operation of rural electrification projects using renewable energy resources, particularly wind, developed and tested	At least eight additional villages and SMEs have installed off-grid wind systems after one year of project completion ***Cannot be verified at the end of the project. Second list of villages selected by DoE.*** ERTC personnel has applied at real projects certification and approval procedures as well as quality assurance activities. ***ERTC has new wind client villages.***	DoE and ERTC records ERTC records	
Output 3.2: Viable financing mechanisms for small-scale off-grid wind systems explored, developed and tested	Eight additional villages and SMEs are financing their off-grid wind energy systems using the mechanisms developed by the end of the project ***No specific financing mechanisms developed besides the standard rural electrification practices (cost-sharing). New revolving or partial grant financing instruments have been considered by DoE for wind projects.***	DoE and ERTC records	

Output 3.3: 5 diesel-wind hybrid and 3wind stand-alone systems installed, maintained and operated	Installed systems are running smoothly according to international standards by end of year 2 ***Can materialize during year 4. Standards set under performance monitoring system.***	O&M files	

2.2.3. KEY REMAINING TASKS

Only ten months remaining of the implementation time, the PMU has to make concerted efforts in performing the main tasks and seek co-operation and support from the main players, including the department, EEC and ERTC. The most important individual remaining tasks include:

- Preparation of the installation and work plans in the pilot villages, including agreement on "rules of the game" with the village administrations;
- Ensuring the installation of the local grids in Beilul and Gizgiza
- Setting up of the performance monitoring methodology, systems and operational indicators for the wind park and the villages;
- Expediting the delivery of the equipment to the villages;
- Engagement in technical and operational trainers' training;
- Implementation of the awareness campaigns and activities;
- Carrying out of the performance monitoring, analysing results and sharing them with stakeholders;
- Involving the potential donors and starting to prepare for the bridging into replication phases.

2.3. OPERATIONAL PERFORMANCE

2.3.1. PROJECT DESIGN

The project design as established in the Prodoc was based on two pillars:

(i) wind measurement over a period of several years;
(ii) preparation of PDF-B by Lahmeyer International.

Wind measurement had been carried out by GoE since 1996. The SIDA funded project had helped establish 25 wind and solar measure stations throughout Eritrea during 1997-2002. Both these activities have established good wind potential existing both in the southern coastal regions around Assab as well as in the Central and North-western highland valleys around Gizgiza and Dekemhare. Reliable data gathered and analysed by ERTC (e.g. the Wind Information System WIS) has helped the project in focusing in pilot areas with real potential for sufficient winds both for larger grid-feeding as well as for village based wind powered generation.

The selection of the Assab Wind Park location was based on the wind information and the existence of the region's Self-Contained System grid (design capacity of 8 MW) and uneconomic and old diesel generating plant. The site selection was made at the start of the project among PMU, ERTC and the TA team to be located near the airport, at about 6 km away from the Assab town. The site elevation justifies the selection despite the relatively high interconnection costs (300,000, almost 15% of total investment costs). Much larger distance would have made the investment unviable in economic terms.

The target size for the pilot was chosen conservatively to cover only a portion of the existing diesel generation replacement potential (generating rated capacity in use of around 3.8. MW and planned rated capacity of the wind park of 750 kW), taking also account of the expected efficiency of the plants. A rough calculation according to the expected would enable 3-4 corresponding units to be established to cover the entire diesel replacement scenario. The choice for the generating units was for medium-sized tilting towers easier to erect and maintain (e.g. no high-rise cranes currently

available in Eritrea). The choice is thus considered sound for a pilot exercise of this kind, despite the higher investment unit costs.

The choice of the selected seven pilot villages was not clearly spelled out in the Prodoc but was made to represent the different wind-prone regions and sub-regions and different uses (household use, desalination, small business, ice-making) and energy-mode combinations. The Southern Red Sea Regional Administration fully endorsed the proposal emerged during the MTR mission for Idi to replace Haleb as pilot target. The PDF-B the boat making activity has stopped (at least temporarily) in Haleb removing the main justification for the choice, whereas Idi is a fast growing fishing and services village half-way between Massawa and Assab with an existing closed grid and diesel generators in place and a wind measurement station in place. Three of the villages (Rahaita, Beilul and Berasole) do not have a measurement station or reliable long-term on-site wind data available. This represents a certain risk and challenge to project implementation and economics, especially in view of the large seasonal and on-spot variations in wind speeds. ***ERTC should make all efforts to establish the minimum wind availability in these locations.*** If adverse data proves lack of sufficient wind availability throughout the year, last minute changes in target locations should be seriously considered by DoE to those with proven wind availability. The choice of seven targets among the identified potential of 300 villages can be considered sufficient for piloting purposes. Some historical wind data was presented by ERTC to the evaluator. Although this data is not very recent, it confirms the availability of sufficient winds, although high seasonal and hourly fluctuations exist in the four villages presented in Annex 6.

Three different sizes of generation capacity per village have been chosen:

- 30 kW (Berasole, Raihaita and Idi[3]) to test replacement/complementing of existing diesel generators within an existing local grid);
- 5-10 kW (Gaharo, Beilul and Gzgiza) for wind stand-alone applications with battery back-up and manly for household use;
- 3 kW (Dekemhare, Gaharo) for wind water pumping (both electric and mechanical).

The choice for testing of the different unit sizes and combinations can be considered sound for the sake of replication, as long as sufficient performance monitoring will be in place. The evaluator considers, however, that two additional types could have been tested in order to obtain a full picture of the real choices of today, namely solar-wind hybrids as well as vertical turbine technology. The former should have been tested especially in high-wind areas where solar technology is already in place and is functioning well. PMU decided not to include the latter due to limited operational experiences in the technology. The decision is justifiable for large scale applications, but would be beneficial for piloting purposes, as the technology may seem to prove simpler and cheaper to use and maintain than horizontal axis wind turbines.

Costing of the investment sections of the project was made somewhat at low-end of industry averages, also taking into account the circumstances (pilot nature, small number of varied units ordered). The pro-forma costing for the wind park was originally estimated in Prodoc at USD 2.2 million including the grid connection and civil works, and around USD 1.0 million for the turbines, foundations and cables. The total costs will be amounting to about USD 1.8 million for the equipment, but the total will be remaining within approximately USD 2.3.million, i.e. within the budget due to the choice by PMU to assign the civil works locally at lower cost. The cost estimate for the equipment and installation of the decentralised units was USD 0.63 million, whereas the

[3] Idi replacing Haleb appears well justified to the evaluator and is recommended.

price of the selected bid will amount to USD 0.98 million, i.e. 55 % higher. Thanks to the budget increase by UNDP, this cost-overrun could be accommodated.

Three main design flaws in the project can be mentioned:

1. Insufficient emphasis put on procurement support and training needed by PMU.

The gist of the project is the physical introduction and procurement of new technology. With proper, specific and hands-on procurement support and training to PMU, much of the delays and complications in the procurement process of the two wind power generation packages could have been considerably reduced. The Prodoc did not plan for the international experts spending time with the PMU on hands-on assistance and on-the-job training, which should have built-in the scope of their work. In addition, the qualifications of the TA team should have been emphasised to include wind park and small generator operations as well as international procurement experience.

2. Lack of clearly defined plan and objectives for a performance monitoring and evaluation system.

The performance monitoring is only mentioned as one vaguely defined task in the Prodoc. It is very difficult to present credible cases for the replication of the various applications without a solid bench-marking basis.

3. Unrealistic reliance of availability of GoE counterpart financing.

Although the GEF rules of covering only part of the costs only have been the basis for the financing package and have been followed, the project financing should have been built on a realistic basis in view of the post-conflict situation and its adverse effects on the overall financial position of GoE. Even the World Bank Group is channelling the majority of its financing exceptionally on grant basis to GoE. The resulting financing gap has caused delays in procurement and implementation.

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2.3.2. IMPLEMENTATION AND MANAGEMENT

The PMU was set-up and started its work swiftly. PMU was physically placed within DoE, which helped integrate it he project within the Department's overall work programmes. The staffing was following the Prodoc. The Project Manager, Mr. Abiy Ghebremedhin, a mechanical engineer, has a solid technical background in renewable energy having served at ERTC as Head of the Research Unit. The project professional assistant, Mr. Teshome Berhane is an economist joining the PMU from the Bank of Eritrea, and thus well complementing the project's requirements. In addition, a secretary and driver were recruited as part of the PMU team.

The TA was selected in a two-step international bidding process and the contract was already in place in November 2004. The first tasks for the PMU and TA in late 2004/early 2005 were site selection for the Assab Wind Park, getting the invitation for prequalification for the park equipment out, confirming the seven pilot villages, establishing two metering stations in Haleb and Gizgiza, arranging in Asmara an initiation workshop on wind energy technology for stakeholders and carrying out of the study tour in USA for PMU, DoE and ERTC in January 2005.

Thus, the project start-up was timely and efficient. However, implementation started to drag after the initial 6-8- months, which was mainly due to the bad performance of the TA in terms of tender

documentation and grid reinforcement design. Table 2.3. below compares the planned and actual fulfilment of the key milestones in the project (as per Prodoc).

TABLE 2.3. PERFORMANCE IN TERMS OF MILESTONES

Milestone	Planned after start-up (July 2004)	Actual/ Expected	Comments
Project office set-up	2 months	2 months	PMU was fully manned in August 2004.
Component 2: Assab wind park Financial close (contract)	5 months	24 months	Target unrealistically tight. Additional delay due to protracted and two-step bidding process. First prequalification notice was sent out only in September 2005.
Wind park in operation	16 months	38 months	Delivery and installation have been smooth with exception of delays in civil works.
Component 3: Decentralised units all pilots in operation	21 months	44 months	Delay due to slow performance by TA and protracted bidding process.
Project completion	36 months	48 months	Additional extension of 6 months may be needed to complete operations monitoring in villages.

The project implementation has been delayed by 1.5-2 years from the planned schedule. The three main causes behind these are a) over-optimistic time-table for the bidding process taking into account the two-step procedure; b) lack of prior experience by PMU and DoE on international competitive bidding according to the World Bank guidelines; c) protracted rounds of negotiations with the winning bidder of component 3; and d) limited procurement experience and hands-on support by the TA team. ***The one year approved extension is considered minimum, and another 6-8 months of extension would be required to finalise the test operation and performance monitoring process for the decentralised pilot village sites.***

In spite of the fact that the PMU was virtually left alone in the procurement process and was not given any meaningful on-the job training by the TA, it has managed to handle the process in a commendable fashion. It has meticulously followed the Prodoc and procurement guidelines and procedures and has done its best in getting the job done and action taken which has been under its control. With better support from competent TA team the PMU could have been more pro-active and also challenged a few shortcomings in the Prodoc, such as the final choice of the pilot villages as well as the insufficient emphasis put on work on the village-based implementation plans and the establishment of the performance monitoring modalities. Some modifications on testing e.g. wind-solar technologies could have been initiated by PMU without challenging the overall objectives of the project, but covering instead all relevant RE alternatives suitable for Eritrean circumstances.

The delayed and only partial implementation of the training components has been the victim of the poor TA performance and the urgencies in the procurement processes taking the whole attention of PMU. The technology specific and wind power operations and maintenance training remains still to

be implemented, once the equipment is fully operational in the park and villages. The evaluator considers it necessary to ***contract this training (not specifically done by the turbine suppliers) to experienced international wind park operators.*** The main part of the awareness creation is also still to be implemented. ***A detailed work plan on this task is still missing and needs to be in place.***

The PMU has managed the project well, according to the Prodoc and has followed all necessary procurement guidelines. The financial records appear to be properly managed and budget situation constantly monitored and adjusted if needed. A separate UNDP audit was currently underway during this assignment, and will cover the details on the financial management of the project. The original detailed work plan established by the TA at inception was abandoned early on. A need for a revised work plan is still there, especially in view of the short time left for completing all work. ***PMU should, therefore, devise such a plan soonest including the roll-out and implementation in the villages, the performance monitoring plans, training as well as the awareness and reach-out activities with stakeholders. Similar performance monitoring system has to be urgently established for the wind park to enable monitoring of the results from day-1 of commercial operation. The recommended new TA sub-contract with international wind farm operator would greatly assist the overall management of the project.***

2.3.3. TECHNICAL ADVISOR (TA)

As no prior experience existed in Eritrea on wind energy technology and investments, the inputs from an international firm with experience in design, operations and construction of small wind parks and decentralised wind power generation systems was built-in the project scope. The Technical Advisor (TA) was planned to assist the PMU and ERTC in the following tasks:

- Establish database of renewable energy potential (wind and solar) in the country based on the information in ERTC;
- Prepare model contracts, tender documents and tender evaluation for the procurement of goods and services for the wind park and decentralised systems;
- Provide engineering support for the grid reinforcement;
- Supervise the installation of the wind park and decentralised systems;
- Analyse operations and maintenance performances of the installed systems;
- Assist in the implementation of the capacity building measures and coach local counterparts;
- Develop procedures for the implementation of rural electrification projects based on renewable energy;
- Organise and conduct public awareness activities on global and national benefits of wind energy;
- Analyse, develop and test practicable financing mechanisms for the replication of decentralised wind energy systems.

The services of the TA were expected to be 12 person-months during year one, 6 person-months during year two and 3 person-months during year three. The consortium of three US firms consisting of Disgen Inc. (wind park operator and lead contractor), Tetra Tech Inc. and Lawrence Berkley National Laboratory (research organisation) was selected after international competitive bidding (see also next chapter). The contract was signed in early December 2004 amounting to USD 420,000 (495,000 budgeted in Prodoc), and their work started promptly in terms of building a work plan, starting with organisation of training activities and assisting in preparing for equipment procurement. The team consisted of three visiting specialists from Disgen, 3 from Lawrence Berkley and 1 from Tetra Tech with 2 home-based assigned specialists. The lead was taken by Dr. van Buskirk from Lawrence Berkley, a physicist of training with prior Eritrea experience ,

who made 4-5 missions to Eritrea. The start-up of their work appeared to be swift and up to expectations.

However, their professional inputs started to become insufficient, especially in terms of support to the preparation of specifications and bid documentation, delayed and superficial and academic working papers and lack of specific training. ***The team active in Eritrea appear to have missed practical wind park operations as well as international procurement experience, which was the most important aspect of their expected value added.*** DoE and PMU having suffered from the non-performance by the TA decided to terminate their contract, confirmed by a Tri-Partite Review (TPR) meeting in November 2006. The consultants were paid USD 210,400 as against the milestones actually reached. ***The evaluator considers their delivery and quality of work as unacceptable and definitely not value for money.***

The work delivered by the TA has covered less than 50 % of the outputs expected and the quality of the work delivered appears highly insufficient and academic, based on the review of the documentation reviewed by the evaluator. The extent of delivery on each contract milestone is presented below.

1. Initiation Report, preparation of library and wind energy training materials and delivery of first series of wind energy training.
The services were provided.

2. Preparation of acceptable Power Purchase Agreement (PPA), wheeling agreement, design, specifications and bid documents for wind park and grid reinforcement designs.
The PPA model was submitted to PMU with a major delay. The document is a plain replica of a Colorado wind park PPA with apparently only minor amendments and adaptation to the Eritrea circumstances and legal system. The document was not properly presented, nor discussed with DoE legal specialists. Thus, its practical value is questionable without major adaptation. The inputs to bid documents came with substantial delays and the TA was unable to deliver the grid reinforcement design and specifications, which EEC later on prepared. (was only partially paid for)

3. Delivery of a procedures manual and initial training for decentralised wind energy systems, preparation of the designs, specifications and bid documents.
The procedures manual was not delivered (incorporated into milestone 5.) and no training was provided (left for equipment suppliers). A marginal input was provided towards the specifications and bid documents. (10 % of the milestone was paid for)

4. Installation of upgraded wind and solar information data base at ERTC.
TA did not deliver this task despite promises. (task was not paid for)

5. Delivery of 6 concept reports for follow-on renewable energy and CDM projects.
The task was included in the contract at the special request of DoE in order to assist the department and developers in preparation of replication investments in the various wind energy applications. TA submitted six reports (see list in Annex 4.) with a considerable delay. The reports were approved by DoE after major amendments requested and subsequently made. The documents reviewed by the evaluator appear very academic, are repetitive to a large extent and will have limited practical value for potential wind energy developers in the preparation of business and investment plans. The reports are biased to detailed technical calculations and towards the processing of CDM applications. Details on procedures and the role of CDM financing for small wind energy projects are hardly useful and practical alternatives because of the marginal subsidy

(max 10-15 %of investment costs), and of the tedious and expensive (USD 100-200.000 per proposal). Thus the practical value of the reports is questionable without major editing and amendments. (this task was fully paid for)

6. Installation and commissioning of Assab Wind Park and first three decentralised wind systems.

The TA played a marginal role in supporting the work on the wind park and was unable to even collect the basic data required by PMU. (task was not paid for)

7. Installation and commissioning of the remaining decentralised wind systems.

No work was done. (task was not paid for)

8. Final operation and monitoring report of the wind park and the decentralised systems.

The performance monitoring system was no designed nor delivered. (task was not paid for)

Assessment: ***The TA left much of the essential capacity building and technical support undone. The lack of on-the-job training and practical wind power generation experience aspects have left a gap into the project, which should be filled, if the objectives are to be fully met with. The evaluator, therefore, strongly recommends DoE to urgently recruit an international experienced wind park operator/consultant to assist PMU, ERTC and EEC in fulfilling the key missing tasks. The unused TA contract funds should be allocated to this purpose. The tasks would cover: a) establishing the performance monitoring system and indicators for the wind park and the decentralised systems and help in monitoring start-up; b) providing technical wind systems operation training for EEC, ERTC trainers and village administration focal points to complement the equipment specific operations and maintenance training to be given by the suppliers, and c) giving international procurement training to concerned DoE, ERTC and EEC professional staff to prepare for replication phases (PMU had to unfortunately learn this "through the heel"). In addition, DoE may wish to consider attaching separate international consultant support in structuring financing solutions and instruments and to identify financing partners for the replication phases.***

2.3.4. PROCUREMENT

The project contains a major equipment component amounting to USD 3.2 million (78 % of total budget), unlike many other institution development and policy related GEF/UNDP projects. This is why careful attention has to be paid on appropriate procedures used and reaching the main principle expressed in UN procurement guidelines, namely the achievement of ***value for money***. The guidelines entail that orders exceeding USD 100,000 are subject to international competitive bidding. The major procurement items, the value and the methods used are summarised in table 2.4. below.

TABLE 2.4. EQUIPMENT AND SERVICES PROCURED

NAME OF CONTRACTOR/SUPPLIER	COUNTRY	TYPE OF PROCUREMENT[4]	CONTRACT PRICE [USD]
Vergnet S.A.	France	Supply, installation and commissioning of 3 X 275 kW GEV MP Wind Turbines of the Assab Wind Farm (ICB)	1,832,371
Musa Ali Construction Company	Eritrea	Construction of Cable trenches, High Voltage Building, Foundation of the three GEV MP Wind Turbines of the Assab Wind Farm (LCB)	n.a.
Eritrean Core Well Drilling Company	Eritrea	Borehole drilling for mini-pile foundation of the three GEV MP Wind Turbines of the Assab Wind Farm (LCB)	20,709
Radya International	Saudi Arabia	Supply of cables, cable accessories and transformers (ICB)	187,332
Schneider Electric Egypt	Egypt	Supply of Switchgear, Low Voltage Distribution Board, Battery and Battery Charger (ICB)	75,300
Fortis Windenergy	Netherlands	Supply, installation and commissioning of Distributed Wind Energy Systems in 7 sites (ICB)	926,839
Disgen inc.	USA	Technical Advisory Services (ICB)	420,000
c/o UNDP		Vehicles (ICB)	41,544

PMU decided, quite correctly, after consultation with UNDP Asmara to apply the most suitable procurement guidelines, i.e. the World Bank ones, for the purpose of ICB, as they provided the necessary templates and instructions for this type of equipment needs, not typical to UN projects. The TA consultants were expected to be able to provide substantial hands-on assistance in formulating the equipment specifications as well as the bidding document packages. The team participated in drafting them with PMU to some extent as reported by PMU to the evaluator, but much less than expected and required. This resulted in substantial delays in the procurement process in both the Assab wind farm as well as the decentralised equipment component bidding documentation. In fact, the TA was not able at all to prepare design and specifications of the grid connection equipment and works, which had to be sub-contracted to EEC.

The whole equipment procurement process has been substantially slower than is normally expected from this type of procurement task. It has seriously delayed the project implementation and has therefore necessitated the one-year project extension. Both packages involved, quite correctly, a two step prequalification method, including the expression of interest as well as the actual bidding

[4] ICB = Interbnational Competitive Bidding
LCB= Local Competitive Bidding

phases. The time line for key milestones in the two main equipment component packages is presented below.

ASSAB WIND PARK EQUIPMENT PACKAGE

- Prequalification invitations published in September 2005
- Shortlisting in Ocgtober 2005
- Invitations to bid sent in November 2005
- Selection (and site visit by Vergnet) in March 2006
- Contract signed in June 2006
- Commissioning in September 2007 (expected)

DECENTRALISED PILOT WIND SYSTEMS PACKAGES

- Prequalification invitations published in February 2006
- Clarification information was sent in March 2006
- Incomplete bid documentation received from TA
- Shortlisting in April 2006
- Invitation to bid were sent in June 2006
- Selection in September 2006
- Additional budget approved in February 2007
- Negotiations with winning bidder aborted in June 2007
- Negotiations with second best resumed in June 2007
- Contract signed in September 2007
- Expected completion of installation and commissioning in April 2008

The total time required for the process for the first one will take 24 months from step 1 and 36 months from project start-up (16 months in Prodoc) and up to contract signature 10 months from step 1 and 22 months from project start-up (5 months in Prodoc). The process has already taken 18 months from step 1 and 38 months from project start-up. As revealed in the numerous steps gone through the delays were caused by multiple reasons beyond the PMU's control but partly caused, the main ones being:

- PMU staff did not have prior experience in the ICB process and requirements;
- TA was unable to provide sufficient technical support to PMU, were seriously delayed in preparing bid documents and lacked the required hands-on approach in their work;
- Several rounds of clarifications were required during the process before contracts could be agreed upon;
- Specifications especially in the second package required several sizes of turbines, not often available from one single manufacturer causing delays in agreeing on exact terms;
- many potential suppliers appear not to have been seriously bidding for the packages and retired suddenly from the process;
- long negotiating process on details with the selected suppliers.

The first package invitation resulted in 22 expressions of interest and subsequently three bids received from the nine invited pre-qualified firms/consortia. Two of the bidders pulled out during the process, resulting in only one fully responsive bid from Vergnet S.A., selected for contract negotiations, which were subsequently successfully completed. The total price was USD 1.8 million and 80% higher than the budgeted amount. The cost per kWh (based on 825 kW) amounts to USD

2,200 and is on a high side compared to international average prices (USD 1500-1600 for larger units with diesel back-up included). The fact that only one qualified bid was received makes comparison difficult[5]. The resulting suitable technology tailored to the Assab winds (e.g. tilt-up tower system, two-speed generators etc.) and the small pilot order would speak for the price premium. Savings achieved in the locally awarded civil works off-set the budget overrun.

The second package also resulted in three fully responsive bids. The first ranked bid from Empower Consultants Ltd. was disqualified during the process due to not sticking to the original terms, and negotiations were continued with the second ranked bidder consortium, Agmin/Fortis**.** A 55 per cent higher price compared to the budget was quoted by the lowest evaluated bid (and in fact all bidders) of USD 930,000 necessitating additional funding to be requested from UNDP. An additional delay was thus caused to the process, before the winning bid could be accepted. The procurement process is still ongoing, although the contract was signed in early September 2007. The reason for the cost overrun can be attributed on one hand to the varied shopping list and many manufacturers required to cover the whole package, and on the other hand to the small order size.

PMU has followed acceptable procurement procedures and has carried out a good quality work given the lack of previous experience and of the expected level of support from the TA team. The selections were made by a Procurement Committee, including detailed technical scoring and taking into account the total price offered. The process has been carried out according to the guidelines and has been properly documented

The selection process of the TA followed appropriate competitive bidding process involving two steps. Altogether 14 expressions of interest were received and resulted in a short-list of four companies. Three technical and financial proposals were received and the Procurement Committee selected Disgen Inc. in consortium with Tetra Tech.Inc.and Lawrence Berkley National Laboratory (USA) for the assignment, based on the scoring and price, as specified in the selection criteria properly disclosed within the invitation to bid. The shortlisting was made prior to the establishment of the PMU by the Selection Committee, but bid evaluation was made after the project start-up with the Project Manager as Committee member.

The procurement for the civil works and the Assab Wind Park interconnection line (grid reinforcement) works were sub-contracted to local contractors, in order to ensure cost savings as compared to inviting foreign contractors. Competitive bidding was used as the selection basis following the Government rules as funding came from the GoE budget contribution.

The two PMU vehicles were purchased by the PMU through UNDP Asmara through procedures commensurate to UN procurement guidelines. The vehicles were confiscated by the Government in early 2005 due to urgent needs elsewhere. This was beyond the control of DoE and UNDP. The project implementation has suffered due to lack of its own vehicles. Office equipment including desktop and laptop computers and printer, furniture and stationery was purchased through local shopping.

ASSESSMENT: The procurement process has been delaying the project implementation by more than a year from the planned schedule. The main reasons have been the non-performance of the TA team, delays in civil works in the Assab Wind Farm component, failed contract negotiations with the winning bidder of the decentralised wind generation component and cost increases necessitating top-up financing for the latter. The procurement process has been

[5] One additional unqualified bid was received by fax, was considerably more expensive (USD 3.9 m.) and was rejected.

conducted according to regulations and procedures acceptable to the UN. PMU has carried out its task without the expected support from the TA in an excellent fashion involving the Selection Committees in all necessary steps and has properly documented the process. Despite the somewhat higher cost of equipment from the estimated levels, the project would no doubt result in bringing value for money and thus contribute to the main objectives for the pilots, and provide a reasonable platform for competitive replication of such procurement in the future.

2.3.5. BUDGET

The project budget of USD 3.9 million was originally based on cost-sharing equally between GEF and the GoE. The arrangement follows the GEF practice of not normally covering major equipment components. The budget is not only sizeable, but also very much directed to the procurement of equipment and civil works, typical of such pilot investment-cum-capacity building projects, much more typical to projects financed by the development banks or from bilateral soft loans. Given the post-conflict status of Eritrea, GEF has flexibly agreed to finance on a grant basis half of the equipment of the decentralised systems component and the grid reinforcement in addition to the "soft" training and technical assistance components. Thus, bulk of the equipment procurement was left to GoE financing, most of which was eventually covered by UNDP.

The UNDP Country Office managed to fill the financing gap with two separate injections of funds approved:

1. UNDP stepped in to cover the budget deficit of USD 1.44 million caused by budgetary constraints. The relatively quick operation caused some delays, but saved the project from total standstill (Assab wind farm equipment procurement was at a critical stage);

2. A 45 per cent higher than expected bid price for the decentralised system caused a gap in the budget. UNDP stepped in again for help approving an additional injection of USD 258,438 into the project budget. The budget revision process took several extra months, but enabled the procurement process continue. This was a critical financial injection for the process, already seriously delayed.

The overall budget situation is summarised in table 2.5.

TABLE 2.5. PROJECT BUDGET STATUS IN JULY 2007

SOURCE	ORIGINAL		REVISED		EXPENDITURE		BALANCEshare	
	USD	% of total	USD	% of total	USD	% of budget	USD	% of budget
GEF	1,950,561	50	1,950,561	47	1,555,699	80	394,862	20
UNDP	-	-	1,698,438	41	503,540	30	1,194,898	70
GoE	1,940,536	50	500,537	12	98,538	20	401,999	80
TOTAL	**3,891,097**	**100**	**4,149,536**	**100**	**2,157,777**	**52**	**1,916,467**	**48**

The GoE share has as the result of the changes diminished to USD 0.5 million, intended mainly for local currency costs and in-kind services. The actual expenditure as of July 2007 amounted to 52 % of the budget. The decentralised systems equipment contract having been signed in early September 2007 the total committed funds exceed USD 3.2 million. Table 2.6. presents the budget utilisation by category and the projected/required expenditure as discussed with PMU.

TABLE 2.6. BUDGET SITUATION AND PROJECTIONS BY CATEGORY

EXPENDITURE CATEGORY	REVISED BUDGET	EXPENDITURE	BALANCE	NEED	COMMENTS
PMU OVERHEAD COSTS	***130,064***	***88,706***	***41,358***	*55,000*	Until end 2008
CONSULTANTS					
TA	420,000[7]	210,400	209,600	300,000	Funds remain in GoE contribution
National	18,750	8,085	10,665	10,665	only
Consultants total	***438,750***	***218,485***	***220,265***	310,665	
					Need for additional USD 90,400
TRAINING	***120,680***	***66,003***	***54,677***	54,677	
					Additional also under consultants
EQUIPMENT[6]					
Wind Farm & installation	1,627,558	1,650,388	(22,830)	420,000	
Grid connection (100%)	703,351	152,316	551,035	-	Includes civil works
Wind Farm total	*2,330,909*	*1,802,704*	*528,205*	420,000	GoE tot.exp 101,758
					No funds restored to
					the GoE budget
Decentralised Pilots inst.	*909,649*	-	*909,649*	930,000	
					based on contract
Vehicles	41,544	41,544	-	-	
EQUIP AND INST. TOTAL	***3,013,033***	***1,844,248***	***1,168,785***		
OTHER COSTS					
Duty travel	70,836	15,535	55,301	55,301	
MT and F evaluations	20,000	-	20,000	20,000	some savings possible
UNDP support cost	20,236		20,146	20,146	
Other costs total	***93,072***	***90***	***95,447***		
TOTAL			**1,916,467**	**1,865,779**	

It appears from the above analysis that the approved project funds will be sufficient**.** The critical issue remains whether GoE can meet its share (USD 209,000) intended for the TA contract, and still in need for the proposed new TA contract, considered by the evaluator critical and essential for the project. The need for additional overhead costs for PMU would be caused by car rental expenses

[7] Represents total contract amount. The original budget in Prodoc was USD 475,000 and the total contract amount before termination was USD 420,000.

and intensified duty travel during roll-out and commissioning phases. PMU has otherwise managed to live very well with the budget and make savings in e.g. civil works category compensating for the overruns in the wind park equipment costs.

ASSESSMENT: ***The 50/50 cost-sharing requirement put to GoE was in its dire financial position due to the post-conflict challenges may have been too optimistic on behalf of the donors, and should have been covered in another way to avoid unnecessary delays. UNDP was efficient enough to step in and rescue the financial framework including the additional funding to fill the cost escalation gap. The cost estimates for the turbines and equipment were not realistic in light of the small number of units ordered and variety of different applications. PMU has managed the budget well in the circumstances. The budget for the additional TA is essential and should be proposed to be covered by e.g. UNDP, if GoE cannot allocate its project funds for the purpose.***

2.3.6. REPORTING AND MONITORING

The PMU has produced the following progress reports, as per the Project Document and UNDP and GoE requirements:

- Project Implementation Reports (PIR): calendar years 2005 and 2006;
- Annual Progress Reports: July 2004- June 2005; July 2005-June 2006;and July 2006-June 2007

Progress and major problems have been recorded in great detail, including all steps in procurement. The reasons for delays and the equipment cost overrun are properly reflected. PMU has also prepared technical papers, including on setting the Assab Wind Park production targets and estimates (will be useful for the performance monitoring purposes).

One Tripartite Review Meetings (TPR) has been held so far. The slow progress was noted and recorded. The two major contributions by UNDP to the budget and the termination of the TA contract were the main decisions adopted by TPR. The project duration was also agreed to be extended by one year until June 2008. ***The TPR mechanism and the positive and flexible attitude adopted by UNDP appears to have helped rescue the project altogether.***

As the PMU is located within DoE daily contacts, briefings and trouble-shooting have been easy for PMU staff. The high level of commitment and interest in the project by the senior department management has also helped in solving day-to-day problems. The Assab site visits by PMU have been periodic and been timed on the critical milestones. Monitoring of the decentralised systems has not started yet. PMU and ERTC could have started the preparations for the roll-out much earlier to clarify the process and responsibilities to all concerned stakeholders.

The UNDP Asmara Office has provided valuable and hands-on support to the project, not only fulfilling its monitoring tasks. On the other hand, it has rightly insisted on the executing role staying with DoE and has stepped in for support when required and requested.

ASSESSMENT: ***The reporting by PMU has been appropriate documenting the procurement process and problems very clearly. The project monitoring by the UNDP Country Office has been active, hands-on, and supportive. An additional Technical Committee would have proved useful in supporting the PMU especially in the absence of an effective TA service.***

2.4. STAKEHOLDER INVOLVEMENT

Department of Energy (DoE)

DoE hosts the project and has integrated the PMU within its proper structure from the very beginning. Day-to-day interaction and contacts with the Department are essential for the project, as the piloting has been included as part of the overall energy and especially the rural electrification strategies of GoE. Wind electricity generation is hoped to alleviate the dependence on imported fuels, high generating costs and thus high electricity tariffs. It is evident to the evaluator, based on discussions with DoE and PMU staff, as well as EEC and ERTC, that the Department is taking the project seriously, is monitoring it closely and gives all the necessary support to it. The GoE budget constraints and the repossession of the project vehicles are external to the Department's control.

PMU has to take pro-active steps to involve all relevant DoE staff, especially those involved in the rural electrification and renewable energy programmes, in the operations, technical and monitoring training as well as in the awareness campaigns. Wind energy should be mainstreamed as soon as possible, and the task would appear to be straightforward and very doable.

Energy Research and Training Centre (ERTC)

ERTC is an essential player prior to, during and after the project life-time. The wind data gathered by ERTC has helped in establishing the site selection and will help in identifying further locations with sufficient wind. The Centre will be the key institution taking over the main responsibility for the decentralised systems, but is already heavily involved in the installation phase.

It appears to the evaluator from the discussions that ERTC has been awaiting the equipment deliveries, before actively mobilising its staff to the pilot villages. PMU should start to involve ERTC fully in the process already now and rely on its extension staff to start with the roll-out preparations with the regional and village administrations. The ownership and sustainability would thus be better ensured.

Eritrea Electricity Corporation (EEC)

EEC has been involved in the project from the very start and has taken the full responsibility for the operation of the Assab wind park. EEC appears to put a high priority for the pilot and looks forward to test its viability. It has made all efforts in helping out in the civil works supervision and grid connection, and stepped in to help in designing the grid reinforcement not prepared by the TA. The wind farm will be fully integrated in the grid system and operating plans. EEC management and technical staff have already participated in the initial training events, and will be part of the equipment specific operations and maintenance training to be provided by Vergnet shortly. PMU and EEC still have to plan, implement and co-ordinate the performance monitoring system and the dissemination of the operating results when starting to become available.
Thus, EEC is in key role in the successful launch of the Assab pilot farm and potential replications/enlargement in the future, in the roles of buyer and operator.

Regional and Community Administrations

The regional administrations of the two regions (Southern Red Sea and Anseba) have an important role in the decentralised systems component, as it has been their responsibility to construct the distribution infrastructure, i.e. the local grid within the pilot villages. The project would only install the wind turbines and connect them to the grid. The Southern Red Sea Administration have together with EEC arranged for the grid installations with diesel power generators in three villages (Rahaita, Berasole and Idi) while Beilul is still awaiting the grid to be installed. Gahro does not need a grid, as the villagers will use portable rechargeable batteries. In Gizgiza the grid still has to be installed. The administrations have already orally committed to building the remaining grids before the wind turbines will be installed. ***A firm commitment and the construction schedules have to be established by PMU together with the administrations.***

The community/village administrations are aware of the plans of introducing the wind power pilots in them stemming from the visits by PMU and the interested bidders. The development has been rather recent, and no specific plans appear to exist, based on the 3 villages visited by the evaluator. PMU emphasised that no unfounded expectations were desired to be raised among the villagers, until the equipment contracts are in place. The communities will have to take the ownership of the technology, be able to run it and maintain it on a daily basis. They also have to cover the operational costs, as well as part of the installation costs, especially inside the dwellings. The villages are also supposed to be providing the necessary performance data for the pilot monitoring carried out by PMU and ERTC. ***Therefore, their active involvement by PMU from the very start of the process is vital in contributing to the installation and work plans, in assigning the focal point maintenance staff to be trained as well as in administering the technical and financial aspects necessary for the up-keep of the systems. This seems to be still missing.***

UNDP

The UNDP Asmara Country Office has played an active role in supervising the project progress and facilitated in its implementation. It has provided valuable operational support and positive interventions in providing the complementary financing to cover the USD 1.44 million budget deficit in the expected GoE contribution, as well as to finance the cost overrun of USD 258,000 in the procurement of the wind turbine equipment for the decentralised component. Both contributions were made quickly and in a flexible manner, delaying the progress a little but securing the implementation to proceed as originally planned. The efficient performance of the UNDP office through the sizeable financial contributions has provided the life-line to the project at a very critical stage***. The office has up to now more than fulfilled its function as the GEF implementing agency and has done an excellent job in the present circumstances. Its continuing close co-operation and support is essential also for the final stages of the project.***

Donors

Partly a design flaw, the project has not involved the donor and financing communities from the very start in project supervision. Given the fact that the potential (and most probably the prospective) replication of larger wind park and the decentralised system in more massive scale will be around the corner, the potential sponsors should have already been given a chance to participate e.g. through an Advisory or Supervisory Committee. The MTR mission met together with PMU with the World Bank Resident Mission, as well as the Delegation of the European Union, and both were only vaguely aware of the project and its purposes, but showed genuine interest in being

consulted and participating in sharing with the results. Both these institutions would have possibilities in stepping in the replication phase as sponsors and also potential co-financiers, if only prioritised by GoE. Donor assistance towards replication investments and e.g. the imminently required replacement of the Assab thermal plant generators should be explored, and initial consultations should already have started, given the lead time needed for decision making.

The World Bank Power Distribution and Rural Electrification Project is well under implementation and has complementary functions in extending new villages to the grid. The Bank is also having an ongoing dialogue with GoE on the utilisation of the uncommitted USD 50-55 million grant funds available for high-priority investments, some of which could potentially be made available for the wind power sector. The forthcoming Bank supervision mission in October 2007 would provide a good opportunity to start the dialogue in this respect, and to present the Assab wind park in operation.

The European Union and GoE are in the middle of finalising the programming of the 2008-2013 co-operation framework and assistance programme of around EUR 120 million. Although the main focal areas are poverty reduction and the roads sector, the decentralised system development could easily be incorporated into the general framework, if prioritised high enough among the parties. The Assab wind park should be presented to the Delegation. In addition, DoE should intensify the existing operational co-operation with the separate Brussels based EU Energy Facility, also a potential financier.

The African Development Bank has shown initial interest in the sector and is already financing through FAO desalination and ice-making investments in fishing villages, including Berasole and Edi wind pilots. In addition, the regional FINESSE renewable energy technical assistance programme would be able to provide support. Neither have been involved or even informed of the pilots, and should be invited to join in. The same applies to the specialised UN agencies with on-going programmes very relevant to the decentralised wind systems, such as FAO (agricultural water pumping, ice-making and desalination in villages, including two of the pilots), UNICEF (water supply projects in several villages with installed diesel generators in place).

Bilateral donors active in Eritrea presently and in the past, such as Sweden (gave valuable support to establish the wind measurement stations and systems in collaboration with ERTC), Italy and the Netherlands would most certainly be interested to follow the results and consider support to the replication stage. It would be the high time to establish the necessary contacts and explore their interest. A number of private internationally active foundations often support renewable energy projects with positive social and environmental benefits. Private corporations, including the major oil and gas companies (e.g. Shell) have embarked on supporting renewable energy research and pilots also in emerging countries. All these potential partners are also worth exploring in this context.

Private sector

The involvement of the Eritrean private sector has so far been limited to the utilisation of local sub-contractors by DoE in the civil works at the Assab wind park. Their use instead of foreign companies has provided savings in the project budget, and has introduced local enterprises to wind park construction work and its special requirements. This is helpful in view of the future projects. The Association of Electrical Contractors has sent their representatives to the introductory training provided under the project. Their more active involvement in the trainers' training and awareness creation is among the urgent tasks remaining for PMU to initiate as soon as possible. The

replication phases will most probably offer growing opportunities for the private sector participation in the construction and O&M activities at the parks and villages. This is very much dependent on the GoE overall policies towards the private sector and specifically those of EEC. The project can still have the chance of being more pro-active in this respect.

Assessment: ***The key participating stakeholders, DoE, EEC and ERTC have been well integrated into the project framework and have contributed to all work in a flexible and efficient manner. PMU has not yet sufficiently involved other important stakeholders into the project scope, such as the village administration, private sector, donor and financing community in view of the imminent start of the park operations and roll-out of the decentralised systems. More pro-active approach should be taken by PMU and DoE in this respect.***

3. GENERAL ASSESSMENT

The various operational aspects of the project have been assessed in connection with the previous chapters. The project cannot show tangible results as yet and many aspects below are more relevant to the terminal evaluation stage, and not at the mid-point of implementation. However, some indications can be given based on the performance so far. The following will analyse in short the progress in more general terms and gives a rating according to the GEF/UNDP evaluation guidelines.

<u>Overall rating</u>: With a view of the substantial delays in implementation, the cost overruns and failure in the delivery of the TA so far, but of the well progressing investment components and the expected strongly positive overall social and economic impacts the overall rating at this moment is considered by the evaluator *moderately satisfactory* and can with intensified effort by PMU, ERTC and EEC reach *satisfactory or even highly satisfactory* at project completion.

3.1. PERFORMANCE

The project has started well with the PMU in place promptly and manned with professionally highly competent staff. The TA having been selected quickly and having started their work in Eritrea soon after gave the project a good kick-off. An initial detailed work plan was in place and most activities started simultaneously, the familiarisation training and procurement in the first place. Six months in the project, the TA team started to fail in delivering their share of outputs, putting all the pressure on PMU to deliver. Their poor procurement and hands-on on-the-job support resulted in delays in the process as explained elsewhere in this report. In addition, the complicated ICB procedures as well as the complications in the civil works and site preparation at Assab wind park dominated the attention and focus of PMU. The training and capacity development and the awareness creation activities have consequently been left with less attention, and need to be re-activated.

The implementation is, however, back on track with the exception of the unfinished TA inputs, still deemed necessary and urgent. PMU has performed its tasks well and in a devoted and punctual manner. More initiatives should perhaps be taken by PMU towards the stakeholders to involve them in the pilot roll-out and performance monitoring, and amore rigorous work plan should have been use to keep with deadlines and manage time. Lack of day-to-day support from experienced wind

power system operations specialists has made PMU to "face the music" alone, which the staff has managed to do in a commendable fashion.

Rating: Project performance so far: Timeliness*: unsatisfactory;* PMU: *highly satisfactory;* TA: *highly unsatisfactory*

3.2. RELEVANCE

The project and the introduction of wind power generation technologies have proved to be very relevant to the present and future developments in the country. The successful utilisation of wind power both in supplying the grid and providing power to more isolated rural communities belongs to one of the new ingredients in Eritrea's energy sector and electrification strategies. If only confirmed as viable in practice, wind power can offer a new source of renewable energy at considerably lower operating and maintenance costs than the presently utilised fossil fuel. The new technology also has the possibilities for enabling to offer electricity at lower cost to the poorest of the communities and improve their living conditions. DoE has demonstrated high priority given to the pilots and appears to put high hopes for the results. Thus, the project is highly relevant to the country's priorities in demonstrating the supply of electricity to those not having it yet, and to those already having it at cheaper cost. Indirect benefits would accrue to the creation of new economic activity in the Assab area and the pilot villages. By attacking two key issues of being in the core of GoE energy sector priorities and of having the possibility to reduce electricity generating costs, the project is considered to have full possibilities in successfully introducing wind power technology in the country, in making its possibilities well known, in testing its viability in generating electricity at lower cost and in an environmentally friendlier way, and providing a reliable basis for considering the replication of such technology where proven viable.

Rating*: The project's relevance is considered highly satisfactory*

3.3. EFFECTIVENESS

The project has progressed beyond mid-point, addressing its initial objectives. It is early to assess, whether the main outcome, i.e. the supply of electricity at lower cost with wind power, can be fully reached. However, the ingredients are there.

Capacity building*:* The shortcomings in the performance by the TA have left a gap in the training as well as advisory support designed for the project still to be filled. The procurement process was delayed due to insufficient hands-on guidance available for the PMU staff and DoE. If the remaining tasks will be assigned to a new TA contract, the gap can still be filled and less damage is done. The technical and operational trainers' training and pro-active launch of awareness and understanding of and publicity for wind energy are planned for, and the establishment of the performance monitoring systems for both main applications will be implemented.

Rating: performance *unsatisfactory,* expectations *moderately satisfactory*

Wind park: Given the presently high fuel and operating costs in the Assab grid, the potential is considered strong. However, as the cost recovery level of EEC is still unsatisfactory, the possibility of passing the cost savings fully to lower electricity tariffs remains to be seen. In this pilot case, the higher investment costs of wind power compared to diesel fuelled generation, are not a factor, as the investments are covered by grant financing. However, given that wind energy is currently subsidised internationally at the rate of 25-40 % of investment or electricity price, wind energy can

offer an attractive alternative, even investment costs included, if a subsidy element is taken into account. The environmental issues will add (internationally 10-15% advantage on CDM terms and CO2 emissions) to the advantage in favour of wind instead of fossil fuels. The technology chosen for the park appears well tested in similar conditions, is versatile also with lower wind speeds and is backed up with a good O&M package. Also the physical installations by the equipment supplier, EEC and local contractors have been made in a highly professional manner, and after the delays the park is ready to prove its case.

Rating: **progress so far *satisfactory* and probability until project completion *highly satisfactory***

Decentralised wind power generation systems: Wind generated electricity will be new to all of the pilot villages, except for Rahaita. Three of the six villages with electricity generating purposes already have the local grid installed with diesel generators. The projects will no doubt enable them to reduce dependence on fossil fuels. The demonstration whether the pilots are technically, economically and socially viable remains to be made. The procurement has been delayed for various reasons, but will be finalised before project completion. The issue remains, whether the monitoring data will be available by that time and is subject to further extension of the completion by at least 6 months for this purpose. Otherwise the demonstration cannot be proved.

Rating: performance now *moderately satisfactory*, probability at the minimum *satisfactory*

3.4. EFFICIENCY

The main cost item in the project, the equipment for and installation of the wind park and the decentralised systems, has been managed well by PMU, having taken the most recommendable, if not the quickest route of going through a two-step international competitive bidding process. The required World Bank guidelines (and thus also UN requirements) were followed to the point ensuring that a fair competition element was included. The cost of the wind park wind turbine equipment excluding the civil works amounted to USD 2,400 per kW**.** The cost is a bit on the high side compared to the international market place on such mid-sized wind turbine technology, but considering its suitability to the circumstances and the pilot nature of the project the wind park equipment can be considered good value for the money. The delays in the procurement and civil works have pushed forward the monitoring of the pilot park performance and results to the last year of the project duration. The delay has diminished the potential total savings for EEC in terms of lower generating costs now incurred later than originally planned for. Currently nearly completed and soon ready for commercial production, the ***wind park can be considered an efficient operation.***

The 55 % cost overrun in the decentralised system should be attributed to two factors: a) optimistic budgeting basis in Prodoc not taking into account the piloting nature and b) the large variety and small unit number of each turbine type and accessories (e.g. mechanical and electrical water pumps etc.) ordered, not available from one manufacturer. The turn-key price of the contract amounts to USD 6,000 per kW for the 160 kW of various sizes of turbines[8], which is rather high and comparable to the average kW costs for photovoltaic (PV) systems. The small order scattered among many suppliers has increased the price of the package. Follow-on larger orders would certainly bring down the unit costs to the same or lower levels.

[8] Rated capacity, includes the water pumps.

The TA contract was awarded to the consortium with the lowest price (20 % weight in the selection) and thus was cost- effective, although not satisfactory from the actual performance point of view.

Rating: The project, as a whole, has so far performed *moderately satisfactorily* in terms of efficiency and has chances of improving to *satisfactory* towards completion. (see also next chapter)

3.5. IMPACTS

As the project implementation is still underway and wind power technology not yet fully installed and tested it is early to draw too many conclusions on the actual impacts. The analysis below, therefore, concentrates on the ***potential and most probable impacts*** that the project can have after completion.

Economic impacts

The Assab pilot wind park possessed a good chance to demonstrate positive economic impacts in terms of providing cheaper electricity than EEC can provide today by the diesel generating plant, measured in terms of lower operating (fuel) and maintenance costs. The PMU has made detailed calculations based on the historical wind measurement data gathered in Assab and the expected output levels of the Vergnet turbines. The conclusion is that the *minimum* energy yield from each of the three turbines is expected to be more than 840 MWh per annum at 90% level of availability (as indicated by Vergnet) and power curve guarantee of 90% even at the capacity rated down to 200 kW per turbine. This is considered conservative and realistic given the present knowledge at PMU, and is higher than the 830 MWh per turbine yield estimated in Prodoc from turbines of 250 kW of rated power.
The annual yield of the park would thus be more than 2,500 MWh helping to displace the more expensive electricity that the diesel plant can produce today.

The comparison of solely the running costs can be in rough terms look as follows:

Average tariff in Assab:	N 2.0 / kWh[9]
Collection rate	80%:
Revenues (based on the above)	N 38 million
Diesel plant	
Peak loads:	1.5 MW cold season
	4.5. MW hot season
Annual generation:	14,000 MWh (2006)
Diesel Fuel cost (to EEC)	N 15.8 /litre
Plant efficiency:	3 -5 kWh/litre
Fuel costs:	N 6.11- 3.16/ kWh
Annual maintenance costs:	N 500,000; i.e. N 36/MWh
Total O&M costs (w/o depreciation):	N 6,150-3,196/MWh (USD 410 -213/MWh)
	N 45-86 million p.a.
For 2,500 MWh	N 15.3-8.0 million (USD 1.0-0.5 million)

[9] based on rough estimation of 30% consumption by large industry (at N 1.08 /kWh), 30% by basic needs industry (at N 2.2/kWh), 20% by other business (at N 2.95/kWh), and 20% by households (at N 1.89/kWh).

Assab wind park

Annual est. generation:	2,500 MWh
Total O&M cost (w/o depreciation)	N 45-90/MWh (USD 3-6/MWh)[10]
Total	N 1.1-2.3 million (USD 0.07-0.15 million)
O&M savings compared to diesel plant (2,500 MW):	N 5.7-14.2 million p.a. (USD 0.38-0.95 million)

The wind park can thus cover at best about 10 per cent of the present generation by the thermal plant. However it can generate electricity at **15 % level of running costs of the diesel generators in place today.** The wind park can thus be able to save around N 6-14 million in terms of running costs at the wind park target production level per annum (USD 0.4-1.0 million p.a. saving compared to the wind park investment cost of USD 2.4 million including civil works). Given that the wind Park investment considered sunk costs (covered by grant), and the fact that the imminent replacements of the thermal plant diesel generators would also be most probably on grant financing basis, the comparison is valid. The higher investment costs of wind power technology (medium to large USD 1,000-2,000/kW) added with the required back-up diesel capacity costs of USD 500-600/kW would make a big difference in commercial terms to pure diesel power, even taking into account a possible 25-40% investment subsidy for "green" wind power.

The economic impact will be the clearly lower generating costs putting less pressure on keeping the electricity tariffs at reasonable levels. Thanks to the wind power EEC can in the future (especially if more wind power capacity will be added) eventually provide electricity to households on a 24 hours a day basis instead of the present 18 hours a day, thus improving the living conditions. But, given the current insufficient cost recovery level the lower costs may only reduce the negative operating margins of EEC and would not be able to affect pricing. Lower pricing would, on the other hand, be required to enable households to afford ventilators and other electric apparatus, currently in very limited use within the Assab grid. The direct stimulus to small business would also increase the level of economic activity in this case. The GoE tariff policy will be crucial in deciding if the lower generating costs of wind power will be carried over to lower tariffs to at least the more vulnerable consumer groups.

The present situation has changed in favour of the wind park since the Prodoc financial projections were made. The amount of fuel saved would be 500,000-835,000 litres based on the PMU present power generation targets for the wind park and the actual efficiency of the thermal plant (3-5 kWh per litre), currently at the low end of the bracket. The fuel costs to EEC will be reduced by between N 7.9-13.2 million per annum at the estimated minimum generation level, thus also saving scarce foreign exchange. In actual fact the benefit to the country will be 47% bigger calculated at the N 22/USD free market rate instead of the regulated rate of N15/USD. The financial projections are based on considerable lower diesel fuel costs (N 0.80 per kWh as compared with N 3.16-6.11 presently), but lower investment cost USD 1.0 million as against USD 1.8 million, a rather low contract price of 5.9 US Cents/kWh (N 0.89), and more favourable exchange rate of N 1.22 to 1 USD. The resulting NPV of income over 20 years was calculated at USD 1.48 million against the investment of USD 1.0 million, showing the positive returns.

[10] based on international industry average (source: IEA)

Without going into detailed calculations, the present returns should be in balance still positive, if not even more favourable for the wind park investment.

The potential of grid connected wind energy generation capacity in the country estimated somewhere between 50 and 100 MW would have a much wider economic impact than the Assab wind park pilot. Even if the current price level available for power generators is high even in international standards, the prospects for private sector Independent Power Producer driven investments are not strong in the near future. The country and the economy have to await the stabilization of the circumstances and a better enabling environment. Financing of such investments (USD 100-200 million) purely on a commercial basis will still be a major issue. Given the limited financial resources available to GoE (budget and donors) large-scale grant financing will also face limits.

The decentralised grids will have to cover half of the connection costs and 100% of the running costs, if the principles of the Rural Electrification Programme will be followed. The investment costs are presumed as sunk costs just like in the case of the Assab wind park. The lower wind power generating costs will have a direct bearing on the tariffs charged to the village households. The strength of the impact can be similar to the example given above, depending on the actual performance of the systems, and is still waiting to be tested. The high unit costs of the wind system investments would make a pay-back analysis comparison look considerably worse vis-à-vis the wind alternative, as back-up power is still required for e.g. ice-making and desalination facilities in the villages. These assumptions in mind, the project can help villagers and their businesses to improve their living conditions and increase the level of economic activity, as they can afford to pay for the new electricity and gradually take in use new appliances over time.

The fishermen are expected to better afford to establish and run ice-making facilities in the villages and thus improve the marketability for their catch to locations further away, including the present markets in Assab and Yemen, and thus help them to increase their size of business through the availability of the cold-chain. (e.g. Berasole village has ice-making equipment installed through an AfDB/FAO assistance programme). The restaurants can afford to maintain cooling equipment and coking facilities and improve their business prospects. The size of the economic impact has to be estimated during the performance monitoring phase in each village towards the end of the project.

Rating: the economic impacts are assessed as *satisfactory* at this moment and have prospects to become *highly satisfactory* at completion.

Social impacts

The availability of electricity to the population is among the key social objectives of GoE. The high price of electricity is presently the other major economic, but also a social affordability factor, for which the project can provide some help. There is clear evidence that a better road access and access to electricity will bring along social externalities and positive developments.

The affordability issue can be reflected in simple consumption terms:

- Single lamp 20-60W (3-9 kWh per month, 5 hrs a day)
- Single fan/ventilator (1 in 20 have it) 60W (11 kWh per month, 6hrs a day)
- Refrigerator 80-250W (1 in 200 have it)(29-90 kWh per month, 12 hrs a day)
- Electric oven for Injera making 3 kW (60 kWh per month, 2 hrs every 3 days)
- Single air-conditioner (1 in 50-100 have it) 3 kW (270 kWh per month, 3 hrs a day)

Electricity for a simple dwelling with 3 lamps, television and ventilator would cost around N 80 (USD 5) per month, one with an additional ventilator, fridge and electric ***Injera***[11] oven N 310 (USD 21) per month, and a household with air-conditioner N 820 (USD 55) per month.

The impact of introducing wind power to the Assab grid on the most vulnerable households would be reaped through the lower running costs of electricity generation and improved affordability for households to make use of e.g. ventilators and cooling systems (fridges etc.), desperately in need during the hot season. The number of households to be connected could also be increased. The current peak load of the households in Assab town and in the two connected villages is around 1 MW and the average consumption is around 250 kWh per month, as indicated by EEC Assab. The possibility of reducing costs for poor households from the current even internationally high tariff of N 1.89 (USD 0.13)/kWh closer to wind generating costs would make a significant impact. Even a moderate reduction in the price to the poor, they could afford to install a ventilator and even a fridge, considered very basic amenities for households. The current consumption pattern is that new appliances will be taken into use when they can be afforded. The starting point is still very low. The possibility for having electricity supply 24 hours a day would have significant positive social consequences.

Small business, including small shops and restaurants consume currently between 500 and 2000 kWh of electricity per month. The price of N 2.95/ kWh (20 US cents) is very high and hampers the establishment of new business and its expansion, and thus indirectly the development of employment and the social fabric.

The social impact for the village household where the local grid is installed will experience the first real improvement step, by introduction of electric lighting, TV, and possibly a ventilator. Some villages have privately installed small diesel or petrol generators or solar panels, but most of them have none. The wind power aspect will bring along savings in generating costs and can thus directly affect better affordability to individual poorer households and to the villages as a whole to improve the social structures, including better health care and schooling facilities. The replacement of kerosene lamps by electric bulbs alone will bring along significant positive health impacts. The development by ERTC of the more efficient cooking stoves is the current development line, not the introduction of electric cooking appliances.

Gender issues

The social impacts of the introduction of wind power in terms of *gender* can be characterised by uniform and positive benefitting both sexes. The specific benefits accruing to female household members include:

- Improved lighting, possibilities for cooling equipment in kitchens increasing comfort and helping daily routines;
- Less health hazards when e.g. kerosene lamps are being replaced electric;
- Villages having improved water supply, ice-making and food conservation possibilities reducing distances to services;
- Improved child care possibilities and amenities.

[11] Local staple bread/food

Minorities issues

The target population consists of numerous ethnic groups and religions living together in harmony, and therefore no evident *minority* issues appear to exist in the project. This was also observed by the evaluator during the visits in the villages.

Rating: If the decentralised pilots can be successfully launched, the social impacts will no doubt be *highly satisfactory*, especially in the longer term.

Environmental impacts

The displacement of utilisation of fossil fuels (up to 835,000 litres p.a.) by the Assab wind park will entail considerable positive environmental benefits. The savings in CO_2 emissions will be in the order of 1,200-2,100 tons per annum (1,701 tons in Prodoc), and 42,000 tons in the *pro-forma* calculated life-time of 20 years of the equipment. If the CO_2 emission reductions would be internationally traded through the CDM process today at EUR 2 per ton (low end market price), the grant injection to investment would amount to EUR 84,000 and ten-fold at the highest prices of EUR 20 per ton seen on the market. The former would not and latter could marginally justify the tedious in average two-year CDM application process, costing around USD 100,000 -200,000 to prepare. (The minimum investment is thus considered to be USD 20 million to make the CDM process worth the effort.). ***Thus, the environmental impacts of the wind park are expected to follow the lines of the Prodoc, if will not become even greater.***

The impacts of the decentralised wind power systems have not been similarly estimated due to their small size and varied applications and uses. The displacement rate of the installed diesel generators will depend on the wind speeds and the actual total demand in the villages (no consumption history so far). The environmental impacts of the project will be positive as compared to the diesel units, and neutral to the stand-alone systems (solar power would be the alternative). The replication phase would be the main focus for major environmental potential gains, when diesel generators are being also used in hybrid systems.

The performance monitoring system should include the measurement of environmental impacts (and CO_2 emissions) into the monitoring process.

Rating: the environmental impacts will be *satisfactory* already from the outset, but if/when operationally proven towards completion, the impacts are expected to be *highly satisfactory*.

Organisational impacts

The PMU is well integrated within DoE and will be giving the Department experience and know-how of launching both larger grid-based as well as smaller village based wind power generating technologies. The specific experiences in international procurement, in the technological and technical opportunities and limitations as to introducing these applications in larger scale will be helping DoE to make realistic plans for the future and help mobilise resources for and launch such investments. The performance measurement system will give the practical tools for this, remaining at the Department even after the completion of the project.

ERTC will hopefully be gaining and adopting within this project a more dynamic operational role than that of a more research orientated outfit until now in helping with the implementation the decentralised wind power systems during and after the project duration.

EEC will be receiving a first experience in integrating wind power into the Assab small grid and will be able to draw conclusions as operator and buyer on its viability for possible further replication also in the larger ICS grid. It will also be able to prepare a basis for attracting independent wind power producers to sell capacity to its grids, and help develop its organisation towards such functions.

3.6. SUSTAINABILITY

The pilot wind power generating investments financed under this project are based on grant contribution, and will thus not create financially sustainable basis for such investment in the future, even if proven operationally viable from technical and operating cost standpoint. The project is expected and appears to be able to establish a credible demonstration on the viability on that basis, and to confirm that wind power is cheaper than the present technology based on imported fuels and solely in use. The financial resources exist under the project to finalise the investments and conduct the commissioning and test runs of the systems.

The fact that GoE was unable to meet half of the project costs and that UNDP covering much of the wind park and decentralised systems equipment and foreign exchange costs does not convince the evaluator on the financial sustainability of the project. The various indirect and in-kind contributions by DoE and the local stakeholders certainly complement the absence of cash contributions at the pilot phase. Much of the forthcoming replication investments are expected to be covered in the short and medium term by donor and grant contributions. The wind park is expected to cover the operating costs of the pilot park and hopefully pass on some of the cost savings to the poorest household client segment, without effects in EEC's financial position. If the grant contribution shares to new wind park investments can be maintained at the maximum international level of 25-40% of the investment costs (or producer price), such investments can be considered sustainable. (Wind power investments are not expected to be fully financially sustainable anywhere in the world today.) The minimum level of the villages' contribution to the pilot as well as the ensuing replication costs are to cover half of the grid installation costs and all operating costs, in order to be sustainable and in line with financing practices in the Rural Electrification Programme. The performance monitoring functions will be able to establish the level of sustainability resulting from the pilots. The largest technical risks are related to the sufficiency of wind and the others relate to the lack of internal and external finance and adverse enabling environment for the private sector to assume replication of good results.

The power sector infrastructure investments and operations tend to be traditionally *top-down* in character, also within this project. The Assab wind park will have to remain very much the core responsibility of EEC, and the clients will hopefully be getting the price benefits from the lower electricity generating costs. Based on the short visits, discussions and observations by the evaluator it appears that the decentralised systems component has started very much in a similar *top-down* fashion, the villages coming into the picture at late stages of installation of the grids and generating equipment. Visits have been made by PMU and TA to the villages to verify and modify the approach. The feed-back received by the evaluator during the field visit backs this notion, but may be incomplete due to the short time available. The sense of ownership and sustainability of the operations could be much increased, if their participation would be invited as early as possible. The

lack of such notion of involving a *bottom-up* approach is considered a shortcoming at this stage, and should be addressed by PMU and ERTC in co-operation with the regional and village administrations.

The other dimensions (socio-political, institutional and environmental) of sustainability have been discussed in the earlier chapters.

The overall sustainability rating of the project reaching its planned outcomes is *Moderately Likely (ML), i.e. there are moderate risks that affect the sustainability.*

3.7. CATALYTIC ROLE

The core of this project is to establish a credible basis for replication investments both in the larger scale connected to the grid and in small scale in rural villages outside the economical reach of the main grids.

With regard to the wind park applications, the pilot appears to have all the ingredients in succeeding in demonstrating a good case for additional capacity added to the park and/or new wind park investments in similar circumstances elsewhere in Eritrea. The commissioning and testing of the park operations as well as 9 months of commercial operation of the park will be critical, but also sufficient to give evidence. A full year of operation is required to prove the case as water-tight, speaking for the extension of the project by 6 more months. The Prodoc has indicated the replication potential in Eritrea to be 15-25 times the pilot wind park size, i.e. 11-19 MW. The Assab grid and the planned maximum capacity of 5 MW of (back-up) fuel oil generating capacity, the technological replication cap would be 4-6 times the pilot size to provide a fully green replacement generating capacity. However, the planned heavy fuel oil replacements for the existing diesel generators will be more efficient (est. N 1.6/kWh), financially setting tighter challenges to new wind power. ERTC estimates that the total wind power potential is 90-100 MW in the wind-rich Assab, Gizgiza and Dekemhare areas[12], and further wind park investments in all these are included in the DoE initial plans. The availability of grant financing remains the main obstacle as of today and in the near future. The possibility for attracting private operators/producers remains for the more distant future, although the corresponding price level (more than 10 US cents/kWh) has already attracted private commercial investors elsewhere in the emerging countries, e.g. in Central America. Total financing needed for the entire potential would exceed USD 150 million.

The Prodoc has estimated the replication potential as 30-40 times the pilots in the 300 villages identified as high wind potential, amounting to 25-35 MW for the while country. The implementation is at such an early stage that no indications exist whether this potential is a realistic target or wishful thinking. The existence of good performance monitoring systems and the development of good cases based on the pilot are the key to attract grant financing and to allocate funds from the Rural Electrification Fund to this purpose. DoE places high priority especially to water pumping, desalination and ice-making as suitable activities in addition to the provision of electricity to households and services. The ability of the villages to cover half of the grid installation and 100% of the operating costs has also to be established within the pilots, and is a condition for sustainable replications.

[12] Gizgiza 30-40 MW; Dekemhare 5-10 MW ; Assab and the South 30-40 MW.

3.8. EXIT STRATEGY

A pilot investment implies replication. GEF and UNDP are financially supporting this project to present good cases for such replication. The end result of the project, if successfully concluded, is monitoring data from the tested pilots providing incentives for similar new projects. The built-in design and implementation plan, however, do not provide for a sufficiently strong bridge to the next phases. As expressed by the evaluator above as a serious concern, UNDP should in co-operation with DoE, the Ministry and the President's Office and the key donors start already now to explore financing possibilities for such replication investments, already high in the list of energy sector priorities. A joint advisory body should take over to overlook and guide the efforts and work on the bridging phases. This would provide a smooth exit strategy for UNDP and GEF and to maximise the catalytic role of the project. Otherwise, there exists a great danger that the project ends with little follow-up decided upon by GoE. Given the financial problems faced by GoE in covering its agreed share in the project cost, this issue is even more crucial.

Sufficient capacity building and training of all concerned is another tool in enabling UNDP and GEF to leave the ball with GoE. As this part of the objectives remain still largely to be achieved, a close attention to this should be given, before definite exit can take place.

4. GENERAL CONCLUSIONS

4.1. CONCLUSIONS

1. The project is addressing one of the key national priorities in securing affordable electric supply to existing and potential clients within the present and enlarging the two main grids, as well to the households and businesses in rural villages outside the reach potential for the grids. It is well placed in the electric sector future investment plans and complements the socially driven Rural Electrification Programme by offering a potentially viable alternative for green and lower cost electricity. It will be able to serve both the households that cannot currently afford but very basic lighting within the grids, but also those households in the rural villages which do not have even those basic amenities, let alone ventilation, refrigeration and related possibilities. The relatively low levels of electricity reach and intensity will provide a wide opening for new renewable wind energy technologies and on the other hand pose a challenge to it to prove the technical, organisational, economic and financial viability of such technology, both at the low and high ends of the size of generating units. The Government is fully behind the project, has internalised in all its efforts and is eagerly awaiting the results for replication possibilities.

2. The project has not been able to "show its teeth" yet in either the grid connected generation or the decentralised village-level applications, and to prove the hypothesis for cheaper, sufficient and reliable electricity supply through wind energy. The procurement and installation processes are still underway in both main investment components due to the long delays in procurement.

3. The general groundwork for the project has been done properly through the establishment of the network of the wind measurement stations and through a sufficient time line of wind data derived from those stations and other measurement work over the past 6-8 years. Continuous collection of reliable wind data is essential and should not be overlooked in the future, either. The site selection for the wind park was based on reliable information in a high-wind region and on an elevated windy site most suitable for the park, but not too far from the grid. The pilot

villages were selected as representative samples within the high-wind regions. One target has been proposed to be changed (from Haleb to Idi), two villages got a metering station from the project and three villages do not have an on-the-spot station basing wind information from the nearest station. Given the high seasonal as well as hourly variances in wind velocity, the lack of accurate information may pose a certain performance risk, mitigated by the allowances for back-up diesel power or batteries built into the project design.

2. The implementation has encountered substantial problems and subsequent delays in the procurement. The capacity building aspects have been left in a secondary order of priority for the PMU in order to mobilise the two investment components. The vacuum left by poor performance by the TA is very much to be blamed on the less intensive on-the-job and trainers' training activities so far. The PMU has performed in a highly professional and devoted fashion, and despite lack of prior experience in international competitive bidding of this scale and complexity of the investment components will no doubt be completed at high technical level. EEC has also performed their role up to standard, and the same standard of support is now to be expected from ERTC in the villages.

3. The efficient launch of the wind park operations and well managed and structured roll-out of the decentralised systems intertwined with properly planned and executed performance monitoring is the core action remaining. But one should not forget the urgent need for pro-active action by PMU and ERTC in filling the gap in the "soft" elements of the project, i.e. training, awareness creation and dissemination of the results. Additional focused help from a new TA contract and experienced wind power operators would ensure the critical quick support and "industry standards" to be incorporated from the very start of the pilots.

4. The project can be expected to manage with the current budget, including a new TA contract, if only the GoE share and earmarked contribution to this purpose is available in hard currency. If not, additional external financing is probably required.

5. It is early to conclude at this stage of project implementation, how well the project can address the main objectives and reach the quantifiable targets (e.g. cheaper electricity). Good indications exist that the technical barriers can be successfully attacked by the pilots. The organisational ones still remain to be proven, and so are the still the pending demonstration of true ownership by the villages and the success of the project to have the necessary amount of persons trained. DoE, EEC and ERTC show high level of commitment as institutions to the project and with additional training inputs would no doubt be able to take over the after-care and replication action. Full-time wind power specialists should, however, continue on full-time basis the work started under this project. The foot-work can start already now.

6. Proper implementation of the pilots can sell the technology by themselves. The project can still go further and help build a bridge to the action to follow, by stepping-up the awareness creation work and reaching out to the stakeholders, including donors and potential financiers.

4.2. LESSONS LEARNED

A more complete feed-back on the lessons learned can only be given at or after the project completion. A few observations can, however, be made already at this stage.

- The procurement process of major equipment component in an investment project (vis-à-vis pure policy or capacity building projects) should be given sufficient time to allow for the necessary steps, including pre-qualification. This applies even more to acquisition of new technology to the country;
- As the procurement and equipment installation function takes a central role in this type of a project, the local institutions and the PMU should be given prior training in international procurement. The PMU had to handle the process and new requirements by themselves in this case;
- The selection criteria of Technical Advisor in this type of project should be concentrating not only on the experience on paper by the proposed firms and team, but also on their operational experience in similar projects. The PMU and DoE should have insisted on the presence of procurement specialists through all the key steps in the process;
- Replacement of non-performing key advisers should be made quickly. PMU appeared overly cautious in insisting on the replacement. The new TA inputs are still valid and urgent to fill the gaps.
- A Technical Committee would be useful in this type of projects to support the PMU in complex issues, such as those above, and help make speedy corrections, to avoid delays in implementation;
- A project work plan should have been re-done and revised constantly and followed by the PMU, even if the TA could not stick to the work plan set by the team. The absence of the decentralised villages installation and work plan component, already overdue, is a good example. Delays happen easily without a precise plan, steps and deadlines;
- Introduction of new technology and concepts require more time and effort in awareness creation. Early action by PMU in reaching out towards all stakeholders is important, in order not to miss the momentum, when the major thrust of the investments is in place;
- Sustainability of the potential replication requires the project to establish together with EEC (on wind parks) and ERTC and villages (on decentralised systems) the criteria, modalities and steps for the replication. General guide books can help if well prepared, but cannot alone keep the momentum after the project completion;
- The bridge to replication, including that to financing has to start well before the pilots are in place, and the players should already be able to follow the whole piloting process. This requires iteration and dialogue not a give-or-take process.

4.3. RECOMMENDED ACTION

The findings of this review assignment would warrant the following recommended immediate action as critical for the successful completion and potential replication of the wind energy applications in Eritrea. The action refers both to the remaining tasks within the project framework as well as those facilitating the potential replication and roll-out of the pilots after the project completion.

1. Concluding the procurement for the decentralised systems

PMU should make all efforts in expediting the delivery of the equipment, now that the contract has been finally signed (was concluded after the MTR mission). The villages should be left sufficient time for the installation, commissioning and establishment of the performance measurement before the project is completed. Given the probability that the delivery will not take place before April 2008, a further extension of 6 months of the project completion date in connection with this component would seem more than necessary and justified.

2. Involvement of the pilot villages and their administration in the process

PMU, ERTC and EEC should take **immediate action** to involve the pilot village administrations in the planning and preparation process for introduction of the wind generation units. Insufficient ground work has been done so far and the villages are very much in the dark. PMU should take the lead in establishing a **work plan for each village** for the introduction of the wind generators within the existing hybrid diesel backed systems or building green-field stand-alone wind-powered grids and generation. The plan should include at the minimum: physical and technical plans and blueprints for the sites and installations, responsibilities within the villages re. operations, maintenance and between the villages and ERTC, operating rules, O&M plans, cost recovery principles (investment and user tariffs), financing arrangements, time-line, identification of the trainees and O&M training plans. Otherwise there will be a big danger to lose the required ownership by the villages and the efficiency and sustainability of the wind power generation systems.

3. Ensuring the grid installations for two villages (Beylul, Gizgiza) and ensuring appropriate wind measurement arrangements for three villages (Beylul, Berasole, Rahaita).

PMU/DoE has to receive the firm commitment by the Regional Administrations covering the two villages and establish the time-frame and plan for and ensure imminent physical installation of the transmission grids within the two pilot villages (oral commitment by the Governor has been received for Beylul and early indication for Gizgiza). ERTC should take the necessary steps to ensure that sufficient additional site-specific wind data can be obtained on the sites with no on-the-spot historical data. Change of target village should be still considered an option in case of uncertainty of sufficient wind availability over the entire year to meet with the demand.

4. Establish the performance, measurement and impact evaluation systems and methodology for the two main applications (international wind systems operation specialists)

DoE should invite assistance from an experienced international wind farm and or small wind generation system operator to establish a **performance monitoring methodology and system** for both the grid-based larger and the decentralised pilots, ignored in the project design. The

establishment of credible technically, operationally and economically viable measured and proven cases for potential replication is critical for convincing the decision makers and financiers. The monitoring systems have to be based on **proven operations experience**, not academic research. PMU should take action in having draft Terms-of-.reference for such additional task prepared, financing ensured from the remaining budget savings or from additional funds and suitable TA providers identified and quickly recruited. The task would require inputs from both wind generation, technical/operations as well as economics/financial specialists, estimated in total of 4 person-months. The costs are estimated not to exceed USD 100,000 allowing for direct selection procedure, as the task is critical and urgent. The unused balance originally intended to cover the TA contract in the GoE contribution could be used for this purpose.

5. Fill the gaps in institutional support and training (international large and small wind generation systems operation technical specialists)

The remaining training should be closely focused on the requirements for the installation, operation and maintaining the wind generating systems in order to complement the remaining technical equipment related training to be provided by Vergnet for the Assab wind farm and by the supplier(s) of the equipment for the decentralised pilots. This gap, intended originally to be covered by the TA, should be given by wind generating systems specialists, not currently available in Eritrea. The additional required international expert inputs are estimated at minimum 5 person-months. The remaining raining budget (approximately USD 54,000) should be allocated for this purpose, and topped-up with other savings (GoE contribution) or additional funding. A service contract combining these tasks with action item 4 above would be the most efficient avenue to implement this task.

6. Extend the completion date and increase the budget if required

The performance measurement and monitoring of the decentralised systems will have to take place after commissioning, which is foreseen in May 2008 at the earliest. The establishment of a sufficient basis for operational data for the result assessment requires the extension of the project until end 2008 for that purpose. The O & M training given by the equipment suppliers is part of the contract. The additional wind systems operations training (new TA) complementing the former would also be extended over that period due to the delays in procurement. The required financing for the two tasks above would require a budget of another USD 200-300,000. If GoE cannot cover the required amount from the balance under budget item 71200: Technical Advisor, additional financing by UNDP, GEF or from other donor sources would be necessary. The sustainability of the project would otherwise be in serious danger.

7. Start immediately the bridging to replication and involve the key donors

As expressed earlier in this report, the roll-out of any new investments in medium and small scale wind power generation would require a substantial grant financing element. As the Assab plant will start commercial operations this October, this time in place provides a good showcase and demonstration to the potential donors, especially the ones with active presence, i.e. the World Bank and the European Union. Both have expressed their interest and potential, if this is an item of high priority within the Government and is taken up in programming negotiations relating to their future assistance. The key for the former are the forthcoming negotiations in September 2007 coinciding the IDA supervision mission regarding the use of the USD 50-55 million uncommitted grant window, and for the latter the negotiations regarding the finalisation of the next 2008-2013 programming cycle support and a budget of EUR 122 million. DoE should take action to discuss the

potential inclusion of roll-out investments within MME and with the President's Office in these financing frameworks. Just to illustrate the maximum investment conservative estimate for the framework for medium term covering the replacement of 75 per cent of the Assab grid capacity (including the 5 MW replacement of the old diesel generation with new) at USD 2500/kW would be USD 12-15 million ingeneration capacity, and covering 30 % of the potential of the 300 villages at 15 kW per village (average of the pilots) at USD 6000/kW another USD 9 million in wind generation capacity, totalling USD 21-24 million, i.e. USD 10-15 million of donor contributions in the next two-three years (expecting their 50 % share).
The interest of the other potential donors should be explored. African Development Bank (and their FINESSE renewable energy programme) already supporting e.g. the fisheries sector with ice-making capacity financing, SIDA with interest and earlier support in the wind energy sector are both in the forefront and should also be explored at early stage and invited to the commissioning of the Assab Wind Farm. Other bilateral donors, UN specialised agencies (e.g. FAO, UNICEF) supporting the related sectors in villages, private foundations as well as international energy firms active in wind energy support (e.g. Shell) fall within realistic potential.

8. Stepping- up of the awareness creation and reach out towards stakeholders

PMU should decisively step-up with the awareness creation work at central, but especially on the regional and community levels, where the level of awareness of wind energy technology, its significance and potential are almost non-existent. The Assab Wind Farm commissioning as well as the imminent action related to the pilot village wind generation should be used as a platform to spread the word and knowledge. PMU and ERTC should prepare the necessary reference material for potential users, beneficiaries as well as service providers, as expected in the project design. This is also the high time to step-up proactive interaction with the stakeholders and informing them of the progress, implementation requirements and early results of the pilots.

9. Select the next round of villages

PMU should take action in identifying the next group of villages for the roll-out programme together with the concerned regions and ERTC, as expected in the Project Document. Initial sourcing of grant financing (e.g. EU ongoing program cycle, the World Bank, UN agencies ongoing village programs) should also be carried out by DoE.

10. Consider the testing of other potential hybrid applications and wind technologies

The project excluded at the outset testing of some applications which could also contain potential down the line. PMU should consider what steps can still be taken within the project scope on testing the hybrid solar-wind applications e.g. in the wind-rich highland valley regions, in order to assess the technical and financial viability of such applications in practice. The same applies to the use of small vertical turbine unit sets, ruled out from the pilots due to the limited international experience of such technology. The potential benefits due to lower investment costs, easier assembly and maintenance and other such factors would speak in favour of field testing of such new applications of future potential.

11. Reviewof the PPA draft critical policies and incentives towards larger independent producer models for the future

DoE should already now start preparing the basis for the future, especially with regard to major expansion of wind generation and supply to ICS and the Assab grids, given the limited available

public financing resources foreseen in the medium term. The draft Power Purchase Agreement model prepared by TA under the project is only the modest starting point, and should still be vetted by local legal experts and EEC suitable to the local legislation (the evaluator has some doubts in this respect, e.g. legal system applied, despite having no legal background).
Although the short-term prospects for private sector and foreign investor interest in setting-up IPP wind generation operations are considered rather slim, DoE should make use of the project as a catalyst and take steps among the concerned authorities to review the enabling environment, e.g. legislation, investment, pricing, taxation, fiscal incentive policies to attract the potential interest for the replication of the commercially viable sized operations especially in large scale wind generation units and parks, foreseen within the wind power potential (estimated in the order of 100 MW based on wind data). The internationally prevailing and accepted public investment subsidy levels of 25-40 per cent would require the clarification of national policies also to that extent. The present Energy Policy and Strategies already emphasise this task in broad terms. Tangible action and foot-work is a prerequisite for any chances in attracting private capital to the industry in the future and belongs to the issues faced during the expected replication.

12. Assist in laying the foundation to integrate wind energy application policy and plan sections within the relevant energy investment programs

The project should provide the replication potential and should help DoE to bring their plans further for the integration of viable wind generation into the concrete power sector investment programmes. The village pilots should be well integrated and harmonised into the forthcoming phases in the Rural Electrification Programme. Once operational results start to be available towards the completion of the project, such policy and planning links have to be created by DoE and EEC. Otherwise the potential benefits from the pilot projects will be lost. DoE and UNDP should take the lead in establishing this bridging link, involving the stakeholders, before the project is over, in order to maintain the critical momentum.

13. Clarify the financing arrangements and alternatives for the replication phases, including the potential links to the Rural Electrification Fund

PMU and DoE should conclude the work intended for TA (and only superficially and academically covered) and devise together with GoE a realistic financing strategy and plan for the replication phase. The task would involve extensive consultation within the Government appropriate agencies and sales work among the already active as well as potential donor community in order to establish a credible and realistic picture for financial planning purposes of the ensued investments.

14. Establish an Advisory Committee, a Technical Working Group and twinning arrangements with capable foreign institutions to support project completion and the following bridging and replication phases.

The highest levels of the Government including the President's office, MEE and the relevant line ministries, private sector apex bodies and key donors should be involved in case the pilot results warrant replication of large scale. An Advisory Committee or a relevant body integrated into the energy policy formulation would be advisable not only on the wind power but also in the renewable energy questions in general.
A technical support group among the stakeholders DoE, ERTC, EEC (including specialists trained under the project) would be advisable to continue with the work started under the project to support further efforts in developing the local capacities in wind energy technologies, applications as well as in implementing investments and running existing facilities.

Continuous technology links and support for wind power programmes should be ensured to keep up with the rapid international technical and operational development in the sector. Establishment of a twinning arrangement with a suitable, qualified and interested foreign wind power operator could provide such a link, supporting successful replication operations. Such long-term co-operation basis would provide the required continuity. Donor financial support would make such twinning arrangements possible and such a possibility should be investigated.

15. Consider imminent replacement of the old diesel generating equipment at Assad Power Plant.

The majority of the installed generators require replacement within the next two years, whereas the remaining life time for the two newest ones can be extended over five more years. The existing demand level, the high operating costs and inefficient output already justify this investment as imminent requirement. The needs for back-up power for the forthcoming pilot phase of the Assab Wind Park will require full-time matching back-up capacity as it starts operations. Any increased wind generating capacity would also need corresponding back-up arrangements. Therefore, the two investment decisions are bound together, should be made soonest and presented to potential (donor) financiers as one package.

ANNEX 1: TERMS-OF-REFERENCE

TOR FOR MID-TERM EVALUATION FOR
Wind Energy Applications in Eritrea
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1. INTRODUCTION

Earlier preliminary analysis has shown that there is significant wind energy potential in southern Eritrea. To investigate and verify this, a study was conducted by installing 25 meteorological stations in various parts of the country. The outcome of this study verified not only that there is a large wind resource potential in the region, but also confirmed that there are also locations with favorable wind conditions in the middle and northern regions of Eritrea.

However, several barriers, such as Capacity /Institutional Barriers, Awareness/ Experience Barriers and Technical Barriers, still hinder progress toward widespread adoption of wind energy technology in Eritrea.

Therefore, a pilot project on "Wind Energy Applications in Eritrea" aimed at removing these barriers and demonstrating the technical and economical feasibility of exploiting wind energy in Eritrea, is underway.

Key components are the installation and operation of a small wind park (750 kW) connected to the grid as well as eight decentralized wind stand-alone and wind-hybrid systems in rural villages. In addition, 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 utilization. Small scale decentralized wind stand-alone and wind hybrid systems will promote sustainable socioeconomic 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 favorable regions, by demonstrating it as a cost-effective electricity generation technology, which can be replicated throughout the country.

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 technically, 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 decentralized wind stand-alone and wind-diesel hybrid systems in the selected wind rich villages and production sites of Eritrea to demonstrate the technical, financial, institutional and socio-economic viability of off-grid wind energy systems.

The Project Document for Eritrea Wind Energy Applications Project was signed on June 2004. Accordingly, a Project Management Unit (PMU) was set up on August 2004.

The duration of the project originally being 3 years, it has now been extended by 1 year. The total project budget was originally USD 3.89 million, out of which USD 1.95 million was secured from GEF, USD 1.44 million from UNDP-CO and USD 0.5 million from the Government of Eritrea (GoE). The total budget was later raised to around USD 4.15 million, when UNDP-CO contributed an additional of USD 258,438 to cover the budget deficit encountered.

The project is executed by Eritrean Ministry of Energy and Mines (MoEM) and implemented by the United Nations Development Program (UNDP) as GEF IA.

A contract for the supply, installation and commissioning of the Assab Wind Farm was signed with a French company, Vergnet S.A., on 30 June 2006. Thus, the construction of Assab Wind Farm having 3 wind turbines with a rated capacity of 275 kW each is on the verge of completion. This site is located at around 6 km west of the town of Assab.

Similarly, the bid for the supply, installation and commissioning of small wind standalone, wind-diesel hybrid and wind water pumping systems of capacities 3-30 kW for 7 Eritrean villages is on process.

An initiation workshop, followed by some study tours and trainings on wind energy technology have been conducted to raise and enhance the awareness of the public, in general, and the skill of the members of the Ministry, in particular.

The experience gained and lessons learned from this pilot project will then be replicated in other wind rich regions of the country.

The assessment of the project impacts during the pilot phase and the extraction of lessons learned both in terms of results and approaches, for replication in other regions, require a proper evaluation of the project performance and to measure the improvements or changes in the designed indicators, as a result of the project intervention, compared to the base line parameters. An initial set of indicators has been identified during the project development phase and is documented in the logical framework matrix of the project document.

The project is seeking the services of a qualified expert to conduct a Mid-Term-Review (MTR). The consultant will assess the project performance, in consultation with the main stakeholders, and identify and describe the main lessons learned from the pilot phase to be disseminated in other areas.

2. OBJECTIVES OF THE EVALUATION

The main objective of this evaluation is to provide the project partners i.e. GEF, UNDP & GoE with an independent review of the status, relevance and performance of the project as compared to the project document, identify and assess the basic results and impacts as to their sustainability and suitability for replication in other areas. The evaluation results are envisaged to identify and describe the lessons learned, through measurements of the changes in the set indicators, summarize the experiences gained, technically and managerially, and recommend the approaches and methodologies for their further dissemination in other wind rich areas.

3. SCOPE OF EVALUATION

The scope of the evaluation will cover the success in removing the barriers, raising the public awareness on potential applications of wind energy technology, strengthening the technical capabilities, appropriateness of policies, the impact and sustainability of activities and outputs.

4. ISSUES TO BE ADDRESSED BY THE EVALUATION

To achieve the above objectives the Mid-Term Evaluation is to address the following:

- Assessment of the project progress towards attaining its objectives and outcomes and recommend measures (if any).
- Investigation of the relevance of these objectives to the national development objectives and priorities, the UNDP/GEF areas of interest and the needs of beneficiaries. Hence recommend means of incorporating those priorities.
- Review of the appropriateness and clarity of the roles and responsibilities of stakeholders and the level of coordination between them.
- Review of the project concept and design with respect to the clarity of the addressed problems by the project and soundness of the approaches adopted by the project to solve these problems.
- Assessment of the performance of the project in terms of timeliness, quality, quantity and cost effectiveness of the activities undertaken including project procurement: both experts and equipment, training programs, etc
- Review of the logical framework matrix and the indicators to assess their appropriateness for monitoring the project performance and to what extent they are being used by the project management.
- Assess the prospects of the sustainability of the project outcomes and benefits and recommend measures for its further improvement.
- Identify and describe the main lessons learned from the project performance in terms of awareness raising, strengthening of technical and financial capacity, efforts to secure sustainability and approaches and methodologies used. Lessons learned in the following areas should be highlighted:
  - End users awareness raising efforts and the impact on the market development
  - Effectiveness of the training activities and its impact on the quality of after sales services. The sustainability of these activities should take into consideration the role of the utility company and its commitment to replicate the introduced wind energy curriculum in other wind rich sites of the country.

- Appropriateness of the current inter-linkages between the major stakeholders and recommend measures for their improvement.
- The future of sustainability of different project achievements in relation to the roles and linkages among the stakeholders.

5. PRODUCTS EXPECTED FROM THE EVALUATION

The consultant shall provide the project partners and the PMU with a comprehensive draft report for review and comments. The report should be preceded by an executive summary. The report shall include:

- Purpose of the evaluation and the methodology
- The main findings: project relevance, efficiency, effectiveness, impact of project activities, sustainability with recommendations for improvement.
- Lessons learned: Assessment of attainment of indicators, operational and developmental lessons.
- Conclusions and recommendations
- Annexes: TOR, Itinerary, List of people met, List of documents reviewed

6. METHODOLOGY OF EVALUATION

The evaluation will be based on the findings and factual statements identified from review of relevant documents including the project document, quarterly operational reports (QORs), Annual Project Reports (APR), Project Implementation Reports (PIR), in addition to the technical reports produced by the project and the different promotional materials. A list of the above reports will be shared with the consultants before the beginning of the mission. The mission will also undertake field visits and interview the stakeholders including the target beneficiaries, government officials (both at the national and regional levels). Participation of stakeholders in the evaluation should be maintained at all the times, reflecting opinions, expectations and vision about the contribution of the project towards the achievement of its objectives.

7. REQUIREMENTS OF THE EVALUATION TEAM

The Consultant shall be a renewable energy specialist having a post graduate qualification preferably in an energy related technical field with around 15 years of relevant experience preferably with wind energy technology development, integration in the general energy balance and the technical, socio-economic and environmental issues of their applications, preferably in the developing countries. Extensive experience in the fields of project formulation and execution is required. Previous involvement and understanding of GEF/UNDP's procedures and monitoring & evaluation guidelines is an advantage. The consultant should have strong writing skills coupled with relevant experience in results-based monitoring and evaluation techniques.

8. IMPLEMENTATION ARRANGEMENTS

The consultant should work towards timely submission of the evaluation report. The consultant will be contracted by UNDP country office in consultation with MoEM and GEF. The Project Management Unit shall arrange for the consultant all necessary site visits and meetings in the project sites according to the TOR. UNDP country office in coordination with the PMU shall arrange logistics for the mission including hotel reservation and transportation during the mission. The mission will maintain close liaison with UNDP Resident Representative, the Department of Energy as well as the PMU.

9. TIME FRAME/DURATION

Duration: The evaluation will be carried out through a period of two weeks in the second half of August 2007. Each week will contain 6 working days per week (where daily fees for Sundays are not paid but only DSA).

The total duration will be 14 working days with the following breakdown:

- 2 working days for reading relevant documents upon receipt from the PMU.
- 10 working days for works in Eritrea (field trips included).
- 2 working days at home base for finalizing the report after receiving comments from GoE and the UNDP.

ANNEX 2: ITINERARY

Saturday, 11 August		Travel Finland - Asmara
Monday, 13 August	a.m.	UNDP: Security briefing UNDP: Kick-off meeting with Sr. Deputy Resident Representative
		Ministry of Energy and Mines, Department of Energy: Briefing with the Director General
	p.m.	PMU project review
Tuesday, 14 August	a.m.	PMU project review The World Bank Resident Mission
	p.m.	Travel by car to Massawa
Wednesday, 15 August		Travel by car to Assab (560 kms)
Thursday, 16 August	a.m.	Assab Wind Park site visit Southern Red Sea Region Administration: Briefing with the Governor Visit to Assab Thermal Power Plant
	p.m.	PMU project review
Friday, 17 August	a.m.	Site visit to Beylul pilot decentralised power village site PMU project review
	p.m.	Eritrea Electricity Corporation Regional Office
Saturday, 18 August	a.m.	Departure by car to Massawa Site visit to Berasole pilot decentralised power village site Site visit to Edi pilot decentralised power village site
	p.m.	arrival in Massawa
Sunday, 19 August	a.m.	Travel by car to Asmara
Monday, 20 August	a.m.	PMU: project review Eritrea Electrical Contractors' Association
	p.m.	DoE: review of rural electrification policies
Tuesday, 21 August	a.m.	Electricity Research and Training Centre ERTC European Union Resident Mission PMU: project review
	p.m.	Eritrea Electricity Corporation PMU: project review
Wednesday, 22 August		PMU: project review Report writing
Thursday, 23 August		Report Writing
Friday, 24 August		Report writing UNDP/DoE wrap-up meeting
Saturday, 25 August		Report writing, departure from Asmara

ANNEX 3: ORGANISATIONS AND PERSONS CONSULTED

Ministry of Energy and Mines, Department of Energy (DoE)
Mr. Samuel Baire, Director General
Dr. Semereab Habtetsion, Director, Energy Development and Management
Mr. Abiy Ghebremedhin, Project Manager, PMU
Mr. Teshome Berhane, Professional Assistant, PMU

Energy Research and Training Center (ERTC)
Mr. Debesai Ghebrehiwet, Director

Eritrea Electric Corporation (EEC)
Asmara
Mr.Woldemicael Berhe, Manager, Generation and Transmission Division
Mr. Ghebrehiwet Abraham, Technical Advisor
Assab
Mr. Salomon Ghebretensae, Assab Branch Manager
Mr. Teshaghiorgis Kelela, Assab Power Plant Manager

Beylul Pilot Village
Village Community Administrator

Berasole Pilot Village
Village Community Administrator

Edi Pilot Village
Mr. Mahmud Ali, Village Community Administrator
Mr. Saleh Mahmud, Area Village Group Administrator

Eritrea Electrical Contractors' Association
Mr.Mulugeta Ghebreigziabher, President

United Nations Development Programme (UNDP)
Mr.Bartholomew Nyarko-Mensah, Senior Deputy Resident Representative
Mr. Yoseph Admekom, Programme Specialist/Manager, Energy, Environment and Food Security

The World Bank Resident Mission
Mr.Samuel Iyasa Zerom, Deputy Head of Mission

Delegation of the European Union to Eritrea
Mr. Steve McCluskey, Programme Officer, Infrastructure and Rehabilitation Section

Vergnet S.A. (at site)
Mr. Claudy Gonzague, Electrical Technician
Mr. Jean Maret, Mechanical Technician

ANNEX 4: PROJECT DOCUMENTATION REVIEWED

Project Documentation

UNDP/GEF: Wind Energy Applications in Eritrea: Project Document

Mid-term Review: Terms-of-Reference

Annual Progress Reports for the Years 2005, 2006

Project Status Report as at July 2007

UNDP GEF Annual Project Reports (APR)/ Project Implementation Reports (PIR) July 2005-June 2006 and July 2006-June 2007

UNDP Project Budget, Revised Budget 2007, Project Budget vs. Expenditure August 2004- June 20, 2007

Technical Advisor: Project Finance Manual, June 2006

Technical Advisor: Project Concept Paper: Wind Power for Grid-Connected Electricity Supply; Gizgiza Pass (ICS) Wind Park, June 2006

Technical Advisor: Project Concept Paper: Wind Power for Grid-Connected Electricity Supply; Assab Wind Park Expansion, June 2006

Technical Advisor: Project Concept Paper: Wind Power for Rural Energy Services in Eritrea; Desalinization, June 2006

Technical Advisor: Project Concept Paper: Wind Power for Rural Energy Services in Eritrea; Water Pumping, June 2006

Technical Advisor: Project Concept Paper: Wind Power for Rural Energy Services in Eritrea; Integrated Wind, Solar Stove Projects, June 2006

Technical Advisor: Project Concept Paper: Wind Power for Export Production; Wind-Hydrogen for Petroleum Refining, June 2006

Technical Advisor: Draft Power Purchase Agreement

Bid and evaluation documents for the Assab and decentralised equipment procurement, TA selection and contract

Selected project related memos and technical documents

Other Documents

Ministry of Energy and Mines: Revised Energy Sector Policies and Strategies (2007)

Semereab Habtetsion, Zemenfes Tsighe: Energy sector reform in Eritrea: initiatives and implications (Article 2005)
UNDP and World Bank procurement guidelines

GEF: Draft Guidelines for Implementing and Executing Agencies to conduct Terminal Evaluations

ANNEX 5: BUDGET COMPARISON

Wind Energy Applications in Eritrea
Project Budget vs Expenditure
August 2004 - June 30, 2007

Budget Description	Budget USD	2004 exp	2005 exp	2006 exp	2007 exp	Total exp	Balance
71400 Secretary	9,000.00	1,049.88	2,400.00	2,400.00	1,200.00	7,049.88	1,950.12
71400 Driver	6,408.00	839.90	1,920.00	1,920.00	960.50	5,640.40	767.60
71400 P. Assistant	25,200.00	3,149.63	7,200.00	7,200.00	3,600.00	21,149.63	4,050.37
71400 P. Manager	36,000.00	2,804.43	7,600.00	7,600.00	3,800.00	21,804.43	14,195.57
72200 Computers	20,456.00	11,568.99	6,795.26	806.67	-	19,170.92	1,285.08
72500 Stationery	15,000.00	1,967.42	3,655.83	502.79	20.45	6,146.49	8,853.51
74500 Vehicle R C	18,000.00	1,201.66	1,668.87	1,413.91	3,461.10	7,745.54	10,254.46
74500 Vehicle (2)	41,544.00	41,544.00	-	-	-	41,544.00	-
GEF Subtotal	**171,608.00**	**64,125.91**	**31,239.96**	**21,843.37**	**13,042.05**	**130,251.29**	**41,356.71**
71600 Demo S& V	55,000.00	2,524.44	34,699.43	664.22	452.00	38,340.09	16,659.91
71600 Tech Training	21,760.00	-	-	11,406.00	16,257.44	27,663.44	(5,903.44)
71600 Managerial T	18,200.00	-	-	-	-	-	18,200.00
71600 On the Job T	25,720.00	-	-	-	-	-	25,720.00
GEF Subtotal	**120,680.00**	**2,524.44**	**34,699.43**	**12,070.22**	**16,709.44**	**66,003.53**	**54,676.47**
71600 D.Tra(Gov. P. St)*	70,836.00	-	3,274.15	5,524.76	6,736.50	15,535.41	55,300.59
71600 Midterm & F Ev	20,000.00	-	-	-	-	-	20,000.00
GEF Subtotal	**90,836.00**	**-**	**3,274.15**	**5,524.76**	**6,736.50**	**15,535.41**	**75,300.59**
75110 Co support costs	20,236.00	-	90.09	-	-	90.09	20,145.91
71200 Tech Advisor	210,400.00		155,400.00	-	55,000.00	210,400.00	-
71200 Nat consultant	18,750.00		7,351.62	733.33	-	8,084.95	10,665.05
71200 Wind Farm inst							-

	322,451.00				322,451.00	322,451.00	
72100 Control D, W F	45,000.00	-	-	-	45,000.00	45,000.00	-
72100 50 % of Grid con	343,500.00	-	-	-	2,451.00	2,451.00	341,049.00
72100 Inst.Decentralized st	607,100.00	-	-	-	-	-	607,100.00
GEF Subtotal	**1,567,437.00**	**-**	**162,841.71**	**733.33**	**424,902.00**	**588,477.04**	**978,959.96**
72100 50 % of Grid con	359,851.00	-	-	-	149,865.00	149,865.00	209,986.00
72100 Inst.Decentralized sy	302,549.00	-	-	-	-	-	302,549.00
72100 Wind Farm Inst	1,036,038.00	-	-	677,638.65	503,540.55	1,181,179.20	(145,141.20)
UNDP Subtotal	**1,698,438.00**	**-**	**-**	**677,638.65**	**653,405.55**	**1,331,044.20**	**367,393.80**
GEF & UNDP,CO total	**3,648,999.00**	**66,650.35**	**232,055.25**	**717,810.33**	**1,114,795.54**	**2,131,311.47**	**1,517,687.53**
Government Share	**500,537.00**	**-**	**-**	**-**	**101,757.87**	**101,757.87**	**398,779.13**
Grand total	**4,149,536.00**	**66,650.35**	**232,055.25**	**717,810.33**	**1,216,553.41**	**2,233,069.34**	**1,916,466.66**

ANNEX 6: WIND DATA ON PILOT SITES
(Source: ERTC Wind Information System)
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ASSAB WIND PARK (1)

MONTHLY AVERAGE WIND SPEED AND DIRECTION FOR ASSAB AIRPORT STATION

	2000				2001				2002			
	10m		30m		10m		30m		10m		30m	
	SPEED	DIRECTION	SPEED	DIRECTION	SPEED	DIRECTION	SPEED	DIRECTION	SPEED	DIRECTION	SPEED	DIRECTION
JANUARY	8,26	134,57	9,14	132,76	8,32	134,95	9,15	133,15	7,57	136,09	8,37	133,89
FEBRUARY	7,53	132,56	8,40	131,13	8,49	132,55	9,31	130,48	10,64	140,30	11,65	138,04
MARCH	8,82	134,03	9,70	133,39	9,27	135,38	10,14	133,88	9,66	139,56	10,64	137,68
APRIL	6,62	121,05	7,38	121,81	7,94	131,67	8,75	129,76	8,86	138,73	9,75	137,16
MAY	5,91	11,06	6,78	2,56	5,39	34,51	6,07	31,08	4,62	349,44	5,32	344,49
JUNE	5,28	352,32	6,09	345,24	5,58	327,58	6,57	322,70	5,47	336,53	6,37	331,52
JULY	5,15	341,95	5,89	334,40	5,59	326,93	6,52	322,04	5,17	21,24	5,84	12,48
AUGUST	5,05	336,67	5,76	331,34	5,37	336,30	6,09	330,38	5,11	344,23	5,80	338,23
SEPTEMBER	5,27	56,33	5,82	51,91	5,65	96,56	6,20	94,52	5,32	64,83	5,86	60,63
OCTOBER	5,16	106,19	5,73	105,23	7,15	128,49	7,84	125,87	8,50	135,87	9,36	133,45
NOVEMBER	9,28	140,36	10,17	138,32	8,87	139,62	9,80	137,17	8,74	140,06	9,70	137,45
DECEMBER	8,38	138,58	9,26	136,65	9,65	143,26	10,61	140,82	7,46	136,22	8,28	133,43
An.Ave.	**6,72**	**118,40**	**7,51**	**118,32**	**7,27**	**123,05**	**8,08**	**122,39**	**7,32**	**126,03**	**8,14**	**124,74**

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ASSAB WIND PARK (2)

Hourly Wind Speed in Assab for 15th of Every Month for the year 2000

HOUR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
100	6,3997	7,4823	5,9722	7,1165	3,917	7,3683	6,4282	2,4978	5,0267	7,565	9,0883	9,955
200	4,9602	6,8263	5,8815	7,0557	3,5232	7,4017	5,7852	2,8845	5,3718	7,645	8,9783	7,9733
300	4,3878	6,0492	7,1615	5,9303	3,2035	8,125	5,4202	2,9715	6,009	8,2233	8,3133	7,8433
400	6,2643	5,8	6,3382	7,4618	3,147	8,5083	6,5042	2,2827	5,204	8,3317	8,625	6,9875
500	6,5335	6,343	5,6832	7,5967	3,172	7,373	4,862	1,8532	4,3535	8,0083	8,3483	6,7785
600	6,5042	6,7778	5,0185	7,5042	2,3442	7,6722	2,6845	2,074	4,1657	7,5367	8,5883	6,2438
700	6,88	6,6702	4,2227	4,7248	2,5365	8,975	2,5022	1,8607	3,4202	7,386	7,675	5,0048
800	6,4033	7,4018	4,2547	4,5483	1,2288	10,318	1,6178	2,142	5,1253	7,5803	9,5017	6,0235
900	7,8403	8,8267	7,262	5,5383	2,315	10,738	2,0942	1,6803	6,3218	8,8017	12,682	7,8763
1000	10,49	10,722	10,37	6,3347	3,464	10,218	6,846	3,8745	6,2607	9,3717	13,185	8,3917
1100	11,212	10,707	8,3933	7,3782	4,3173	10,678	4,55	4,9703	6,5117	10,313	14,082	8,54
1200	12,133	9,6383	8,5617	8,5833	4,7405	10,555	3,7993	6,306	7,2917	10,17	13,558	9,055
1300	12,668	9,52	9,77	9,5933	5,694	11,462	6,1265	7,0515	7,6083	10,132	13,162	9,6033
1400	12,727	10,02	9,8983	9,4083	5,787	11,173	6,8573	6,9103	7,2323	10,358	13,225	9,1817
1500	13,207	10,497	10,018	10,438	5,4345	11,617	6,6353	7,6768	5,2777	10,192	12,982	7,4267
1600	13,232	11,55	10,388	10,015	5,7008	11,238	5,7103	7,103	4,6148	9,8083	13,073	6,2905
1700	12,673	10,998	10,77	9,3183	5,7317	11,207	6,2232	6,262	6,6855	9,815	13,298	4,7963
1800	11,205	10,257	10,885	9,0267	4,1758	10,483	3,5093	6,0387	9,0467	9,3083	12,462	2,7163
1900	10,385	10,71	10,053	8,3117	3,0323	9,2417	3,0555	6,5253	9,2817	7,9417	11,418	1,4388
2000	10,602	10,507	8,335	7,4765	3,8758	8,48	4,7245	6,795	6,2677	7,412	9,2817	1,9652
2100	10,048	10,175	8,855	7,5317	4,5898	7,5428	7,0442	5,2393	4,1702	7,8333	11,115	4,8663
2200	8,8483	8,7833	9,2633	8,445	4,7652	7,7817	7,9793	4,4777	7,4697	8,2817	9,205	7,0202
2300	9,425	8,2067	10,297	8,1812	4,8812	7,125	8,0583	5,0953	6,1817	8,845	9,5133	7,6333
2400	7,504	8,2467	10,263	6,2288	4,0425	6,6835	8,3867	4,6407	6,364	7,8922	10,118	6,1757
	9,272192	8,863138	8,246463	7,656138	3,98415	9,24855	5,308508	4,550546	6,0526	8,698008	10,89493	6,657792

ANNEX 6
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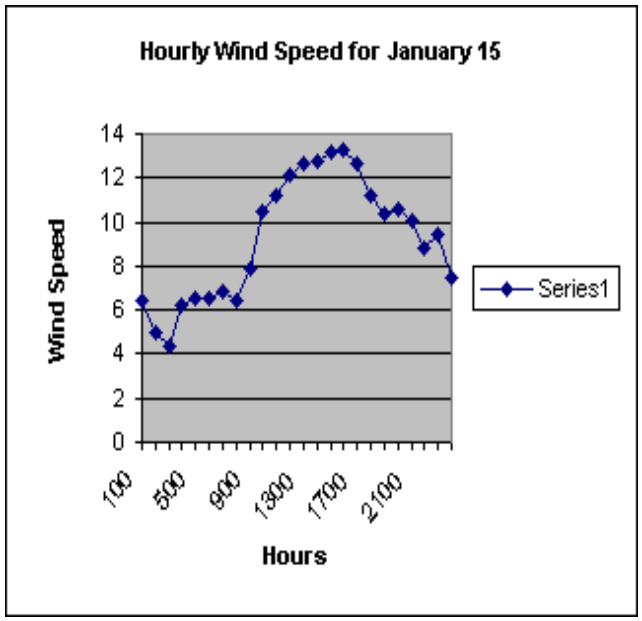
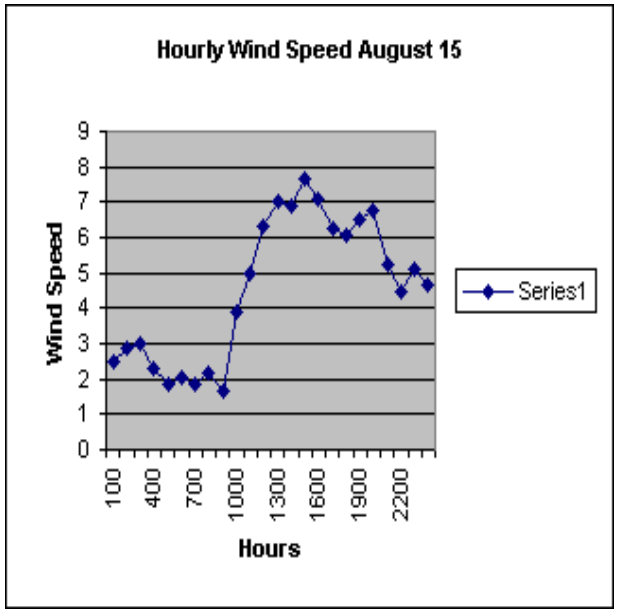
ASSAB WIND PARK (3)





ANNEX 6
page 4 of 15
GAHARO VILLAGE (1)

MONTHLY AVERAGE WIND SPEED AND DIRECTION OF GAHARO

	2000		2001		2002		2003		2004		2005	
	speed	***direction***	***speed***	***direction***	***speed***	***direction***	***speed***	***direction***	***speed***	***direction***	***speed***	***direction***
JANUARY	8,7003	139,63	8,0138	171,71	x	x	8,6164	354,77	9,1319	355,54	8,6927	355,4
FEBRUARY	7,9696	140,34	8,6617	168,41	10,383	354,72	8,589	354,79	8,8187	355,6	8,7753	3,775
MARCH	8,9402	140,87	x	x	9,7719	354,74	8,5496	354,8	8,6462	355,54	8,9784	125,95
APRIL	7,2345	138,79	x	x	8,5553	354,75	8,6129	354,79	7,915	355,49	9,7717	128,91
MAY	5,3988	332,69	5,6013	354,72	5,2459	354,76	7,7579	354,8	5,2024	355,49	5,7705	7,9178
JUNE	5,7912	358,66	6,3356	354,74	6,1687	354,77	5,8634	354,8	5,6745	355,45	5,5377	333,19
JULY	6,0184	335,63	6,7657	354,76	5,5141	354,76	8,1767	354,78	6,5978	355,41	7,4346	308,5
AUGUST	6,0606	328,09	6,2848	354,73	6,165	354,76	6,1857	354,78	6,9476	355,4	5,5812	326,05
SEPTEMBER	5,8269	76,947	6,1783	354,71	5,4345	354,76	5,3669	354,78	5,309	355,41	5,1963	340,73
OCTEBER	5,6837	130,44	7,4505	354,72	8,6265	354,76	8,1549	354,8	8,453	335,38	7,7461	126,97
NOVEMBER	7,9517	354,7	x	x	8,9507	354,76	9,6797	354,79	9,0868	355,37	9,1925	129,82
DECEMBER	x	x	x	x	8,0112	354,77	8,306	355,1	8,765	355,4	x	x
	6,9075	**129,14**	**7,1417**	**357,05**	**7,4509**	**354,76**	**7,9365**	**354,82**	**7,5797**	**355,46**	**7,6426**	**66,523**

Station Height= 10 m

ANNEX 6
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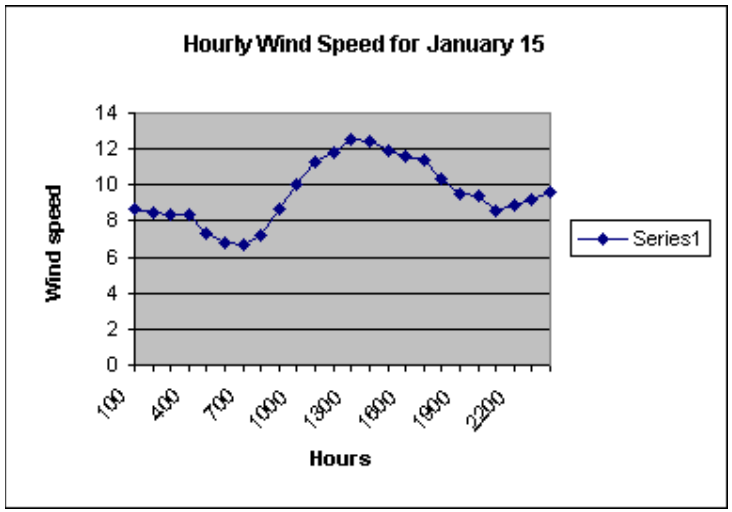
GAHARO VILLAGE (2)

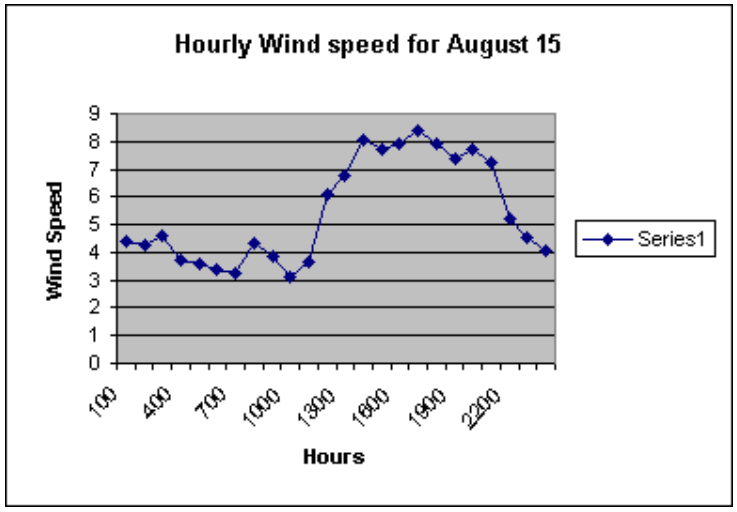
Hourly Wind Speed in Gaharo for 15th of Every Month for the year 2000

HOUR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
100	8,655	8,3233	7,6917	6,0672	3,7312	6,2265	6,4442	4,4277	6,0432	7,9733	9,2367	6,9233
200	8,4883	7,9017	7,7333	5,3298	3,5627	6,0903	6,8582	4,2397	6,5382	7,6523	8,0167	6,2788
300	8,34	7,3877	8,0933	5,9297	3,0328	5,92	6,2243	4,6033	6,8167	6,7472	8,0833	6,5618
400	8,3583	7,124	7,4425	5,151	2,3075	5,8147	5,9932	3,6903	7,3683	7,9417	7,915	6,7852
500	7,2767	6,7353	6,8685	3,7315	2,8992	8,0583	3,8583	3,5717	7,6767	7,5983	7,7117	7,1195
600	6,777	6,8367	6,1893	3,4255	2,8718	8,425	5,0965	3,3748	7,1727	7,3367	7,5383	6,3225
700	6,6425	7,4567	6,5742	3,4283	1,968	8,19	4,1433	3,2647	6,5795	8,21	8,0233	6,3522
800	7,2585	7,68	6,6182	4,6308	1,0177	9,1717	3,5898	4,3195	6,7007	8,8233	9,42	7,1955
900	8,6367	9,4933	8,9467	6,7913	1,4922	9,1867	4,082	3,8775	6,1037	9,1733	11,005	9,1333
1000	10,012	10,688	9,415	7,1363	2,9807	10,058	5,7663	3,1217	6,9095	9,2417	12,108	10,443
1100	11,315	10,863	9,3033	9,605	5,0738	9,9883	6,3978	3,6807	5,5285	10,17	12,277	10,68
1200	11,857	11,4	9,4067	10,403	7,5388	9,85	7,2402	6,0902	7,181	11,018	12,445	10,947
1300	12,542	11,525	9,9833	10,338	7,3813	10,572	7,2848	6,785	7,69	9,945	12,863	11,493
1400	12,45	11,97	10,458	10,195	6,8573	10,598	6,7207	8,085	6,4803	9,445	12,64	11,512
1500	11,953	11,807	10,848	10,218	6,3362	10,423	6,5593	7,7383	4,4978	9,76	12,178	11,295
1600	11,608	11,672	10,743	8,5283	6,6725	10,612	7,5992	7,8933	5,0018	9,3117	11,818	10,787
1700	11,408	11,26	10,852	8,63	7,2683	10,717	8,1033	8,3733	10,057	8,57	11,035	10,167
1800	10,37	10,667	10,587	8,3567	6,0855	10,225	7,2702	7,9067	8,7258	8,0817	10,415	9,17
1900	9,4667	10,468	10,452	7,6333	6,102	8,865	6,367	7,3598	8,5608	7,49	9,045	9,2267
2000	9,3617	10,393	10,627	6,5653	5,5903	8,715	6,189	7,695	5,6953	6,8232	8,6483	9,4583
2100	8,5383	9,55	10,883	6,7833	4,3273	8,1083	7,4303	7,2258	4,3143	7,69	9,3217	10,167
2200	8,9217	9,4233	10,94	6,9773	4,8463	7,3802	9,005	5,2058	3,3927	8,085	8,9233	9,0767
2300	9,2383	9,255	9,99	7,345	4,7783	6,316	8,9867	4,566	5,1007	7,6087	8,7633	9,2033
2400	9,6567	7,695	10,027	7,1865	4,515	6,208	8,04	4,0918	5,6765	8,1033	9,12	9,775

ANNEX 6
Page 6 of 15
GAHARO VILLAGE



High Season



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ANNEX 6
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DEKEMHARE VILLAGE (1)

MONTHLY AVERAGE WIND SPEED AND DIRECTION OF DEKEMHARE

	2000		2001		2002		2003		2004		2005	
	speed	*direction*	*speed*	*direction*	*speed*	*direction*	*speed*	*direction*	*speed*	*direction*	*speed*	*direction*
JANUARY	6,366057	30,465	6,621	29,163	N/A	N/A	5,9233	29,189	4,9826	25,174	5,1563	26,046
FEBRUARY	6,237353	30,147	6,035	30,522	N/A	N/A	5,5298	31,224	5,7026	30,587	6,0369	29,781
MARCH	5,975021	30,987	5,086	31,014	N/A	N/A	5,6736	31,084	5,6694	34,485	5,5634	33
APRIL	5,375835	40,657	N/A	N/A	N/A	N/A	5,5181	32,938	5,4988	33,911	5,9221	33,687
MAY	6,42773	37,572	5,855	30,58	N/A	N/A	5,3785	37,983	6,4124	35,307	5,6404	31,924
JUNE	6,192262	22,539	6,027	221,85	5,3744	230,96	6,2226	309,58	N/A	N/A	5,9771	25,69
JULY	6,146324	231,59	5,765	220,35	5,7233	226,6	6,0062	230,92	6,2316	233,23	5,8396	229,2
AUGUST	5,929269	236,16	N/A	N/A	5,8076	223,84	5,3708	219,98	5,6069	221,94	5,5022	218,07
SEPTEMBER	5,378767	43,073	N/A	N/A	5,796	37,364	5,8132	43,254	N/A	N/A	6,0018	39,107
OCTEBER	6,04946	33,792	N/A	N/A	5,9963	34,247	6,4811	33,213	5,7914	34,546	6,7158	32,822
NOVEMBER	5,708172	31,973	N/A	N/A	5,7097	31,456	5,9576	34,081	6,0223	32,297	6,4941	32,295
DECEMBER	5,776999	29,688	N/A	N/A	6,0024	30,315	6,3059	31,287	6,2371	29,249	6,1538	31,873

N.B. Wind speed in m/s while direction is degrees.N/A means there is no data.
Station Height= 10 m

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DEKEMHARE VILLAGE (2)

Hourly Wind Speed in Decemhare for 15th of Every Month for the year 2000

HOUR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
100	2,7373	4,7455	5,021	2,1497	1,6632	4,2915	6,101	4,7473	3,2937	3,543	0,8805	2,3265
200	1,476	3,5063	5,7565	1,5967	1,9665	3,1147	6,6745	5,5815	2,5727	3,3048	1,1823	1,8112
300	1,051	4,2472	6,7285	1,4418	1,2218	3,13	5,9342	4,3815	3,3902	2,1375	1,6592	2,2538
400	1,3422	5,1103	7,405	1,5897	1,0022	2,277	6,5155	2,9768	3,3992	2,6657	1,9692	3,2233
500	4,3335	5,5283	6,6888	1,1635	0,983	4,4197	7,2572	2,519	4,5657	1,9008	1,5045	3,7652
600	4,7238	6,1642	6,6553	0,93717	3,3958	5,0462	6,2433	3,3217	5,5042	1,7763	1,687	3,7005
700	4,659	5,8277	5,5827	1,4327	3,6575	4,7803	6,2737	2,1312	4,9517	2,211	3,8973	4,4475
800	5,221	5,403	3,2728	2,6183	4,2525	4,2588	5,6568	3,12	4,6698	3,6723	4,0903	4,6303
900	5,5537	4,92	1,7897	3,4153	3,61	5,0562	6,7728	1,9973	4,4223	4,7437	3,4197	4,442
1000	6,7965	4,3265	2,3692	3,9187	3,0592	3,8888	5,5008	2,2632	2,052	3,8068	2,4642	5,4028
1100	7,1143	5,2848	3,4848	4,735	4,3148	2,4992	4,881	6,2595	3,6728	1,6068	3,0462	6,5497
1200	7,7662	6,0947	3,7532	4,6943	4,9668	2,7367	4,609	6,9063	7,6513	2,914	3,889	7,2252
1300	7,678	6,3222	5,1458	4,6838	3,2128	4,8297	6,796	7,3135	8,9417	3,1985	3,3848	6,6633
1400	8,2867	6,2153	6,096	6,5972	2,2385	8,0783	8,8678	6,6998	9,9333	2,8202	4,526	7,729
1500	7,7623	6,7553	7,825	7,541	6,69	9,0133	7,1987	7,5197	9,8833	6,812	6,675	9,4517
1600	7,5507	7,47	9,0633	9,785	7,55	9,6117	2,1587	9,3037	9,7783	8,9517	6,5745	10,522
1700	4,7372	7,6767	9,1267	7,0027	8,0927	11,212	5,9758	6,9663	10,548	6,1648	7,0762	10,672
1800	5,2688	7,746	9,1667	4,3038	10,252	11,702	7,2823	6,1438	9,3633	4,6035	7,1182	9,73
1900	5,2813	8,7467	8,145	4,6213	9,5567	11,46	6,736	5,4092	8,0017	6,017	6,9343	9,6567
2000	5,3137	6,7993	7,445	2,4907	9,3717	9,4833	7,5303	6,4858	6,082	4,0262	6,3815	9,525
2100	4,1828	5,9138	7,0932	4,8353	8,435	8,42	7,2387	3,332	2,2395	2,6955	6,5157	9,0417
2200	2,075	5,318	5,8833	3,2768	7,1042	7,2812	6,3168	1,0633	1,1772	1,814	4,9855	8,2933
2300	1,1618	5,3178	5,206	4,2173	4,4327	5,8915	6,1415	3,0658	1,9402	5,174	3,5988	8,065
2400	1,5578	6,0955	4,4168	4,4147	2,8425	4,997	7,1662	1,9935	1,1562	8,5433	2,3092	7,6583

ANNEX 6
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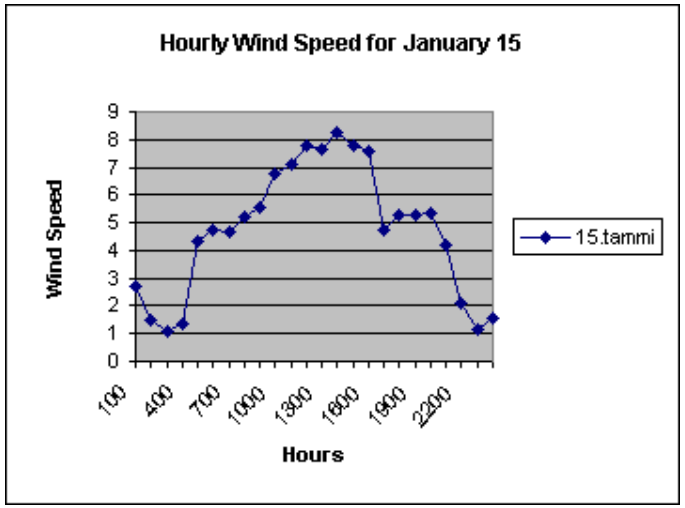
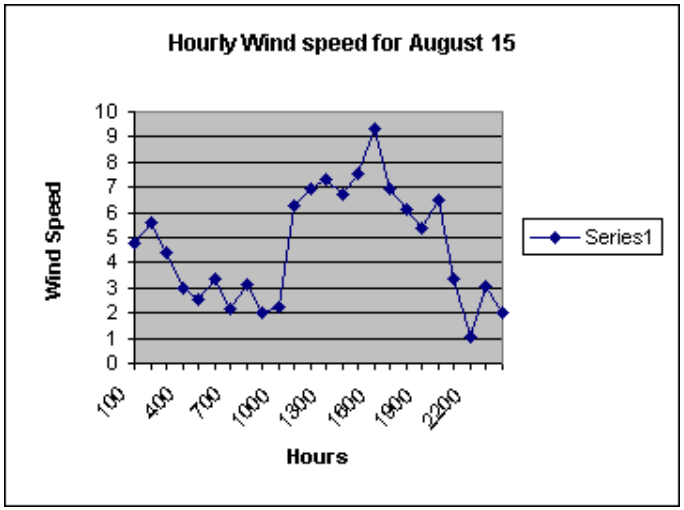
DEKEMHARE VILLAGE (3)



High Season



Low Season

ANNEX 6
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IDI VILLAGE (1)

MONTHLY AVERAGE WIND SPEED AND ITS STD DIRECTION OF IDI

	2000		2001		2002			2003		2004	
	speed	*direction*	*speed*	*direction*	*speed*	*direction*	*StdWS*	*speed*	*direction*	*speed*	*direction*
JANUARY	4,9212	106,92	4,9615	103,75	4,7718	85,209	0,55004	5,2263	106,09	5,7234	101,17
FEBRUARY	4,7939	96,456	5,0283	99,207	7,054	116,14	0,84456	5,3248	70,157	5,6558	88,459
MARCH	6,1375	85,067	5,8722	99,667	6,6813	96,755	0,76104	5,515	54,761	5,7171	89,299
APRIL	N/A	N/A	N/A	N/A	6,518	93,77	0,75512	6,0081	89,105	4,9054	85,671
MAY	4,0542	6,9781	N/A	N/A	3,5712	352,88	0,3411	4,7475	90,538	3,492	2,2511
JUNE	4,0719	0,48004	3,7759	323,81	4,1435	333,4	0,40442	3,7309	346,6	3,8558	339,91
JULY	3,4559	10,933	3,6367	350,36	3,457	0,72679	0,38735	3,7599	332,3	3,7146	342,39
AUGUST	3,7651	352,38	3,7873	353,77	3,5933	8,2883	0,38079	3,5107	1,6419	4,0283	334,85
SEPTEMBER	3,8575	35,787	3,8469	52,737	3,7851	48,335	0,42548	3,7651	349,29	3,7038	17,369
OCTEBER	3,6047	64,913	4,4327	96,661	5,2157	107,14	0,61322	N/A	N/A	5,2589	108,93
NOVEMBER	5,9017	117,85	5,3794	118,78	5,7149	116,7	0,68238	N/A	N/A	6,2429	119,09
DECEMBER	5,5572	113,63	6,4205	123,2	4,858	109,63	0,59119	N/A	N/A	6,2631	118,56
	4,6045	72,132	4,1385	85,596	4,9286	76,762	0,559	4,675	51,706	4,9009	72,266

N.B. Wind speed in m/s while direction is degrees. N/A mean there is no data.

Station Height= 10 m

ANNEX 6
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IDI VILLAGE (2)

Hourly Wind Speed in Idi for 15th of Every Month for the year 2000

HOUR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
100	4,364	3,3113	3,0858	2,764	2,989	3,4122	1,9727	1,0415	2,1425	5,0102	8,6133	2,3185
200	3,8818	3,4128	3,1678	3,521	2,8285	2,042	2,5063	1,0975	2,539	4,7383	8,1567	1,5207
300	4,3432	1,8463	1,783	2,8005	2,5383	2,0582	1,1835	1,2612	2,9435	1,8873	8,1283	2,622
400	2,3152	1,6288	2,7533	1,2072	3,1168	1,6212	0,982	2,3562	2,6033	1,8017	7,9123	3,3918
500	1,2413	1,2908	3,2762	1,5373	2,9908	0,438	1,2278	1,6807	2,3835	2,4945	8,2733	4,3138
600	1,0762	1,6803	3,659	1,0725	3,5217	0,63817	1,0472	0,2735	1,356	2,835	8,21	3,8693
700	0,33083	0,751	3,4078	1,7483	2,703	1,3397	1,3238	0,40683	1,0563	1,9715	8,3417	3,642
800	2,3472	0,61167	2,9325	1,7003	2,4007	0,77583	1,2613	1,6293	0,58267	1,2445	7,72	4,0145
900	1,321	0,72583	2,067	2,437	2,6385	1,1052	0,633	2,8668	1,5895	1,3023	7,765	2,0312
1000	1,8028	1,704	2,745	3,1835	3,049	1,7858	2,1335	4,0807	3,5193	3,1622	8,2617	1,3102
1100	2,3722	4,2558	4,3243	4,5812	4,2377	4,0055	4,4053	3,7538	4,8433	5,6885	7,965	4,1742
1200	2,762	5,9412	7,7753	4,8578	5,8105	7,273	4,587	4,5913	6,223	7,0615	7,6295	5,9475
1300	2,6178	8,0367	10,537	4,6138	6,6682	10,432	4,9318	5,0848	6,659	7,6408	7,1347	6,634
1400	4,4995	7,7183	11,282	6,7868	7,465	9,66	4,985	5,2347	6,5368	10,638	9,4227	6,9848
1500	6,5173	8,14	12,1	8,4267	5,894	8,6217	6,0103	4,958	7,0285	10,577	11,905	6,7345
1600	11,32	8,905	11,293	8,535	2,0823	8,0917	6,108	5,1428	8,075	10,065	11,818	4,6445
1700	11,128	7,945	10,442	7,5033	2,469	6,4035	4,5688	5,0572	9,12	9,405	11,76	8,4897
1800	11,772	6,3228	8,6867	6,9273	4,171	4,9557	3,5918	4,9812	7,7033	6,8218	10,74	8,88
1900	11,407	6,681	6,7427	5,7125	2,9455	4,8553	3,1182	4,2883	6,6735	5,2542	10,073	8,925
2000	10,775	6,2883	6,5373	5,5078	1,4553	5,5615	2,0305	2,5157	5,9538	4,7927	9,2983	7,1062
2100	9,6067	7,0983	6,4103	4,8018	0,75317	4,4447	1,6148	1,3495	4,1765	5,1193	10,087	4,7167
2200	9,1567	7,3952	5,852	3,8903	1,8317	3,3895	1,0038	1,069	3,7022	4,9832	9,4333	3,4405
2300	7,7333	6,8017	5,944	2,6163	2,7845	2,4318	1,9868	1,8057	2,253	4,5543	9,2367	2,8448
2400	8,1983	5,7983	5,3992	2,768	2,8568	1,9762	2,92	1,4867	3,6093	3,9597	8,7317	2,6235

ANNEX 6
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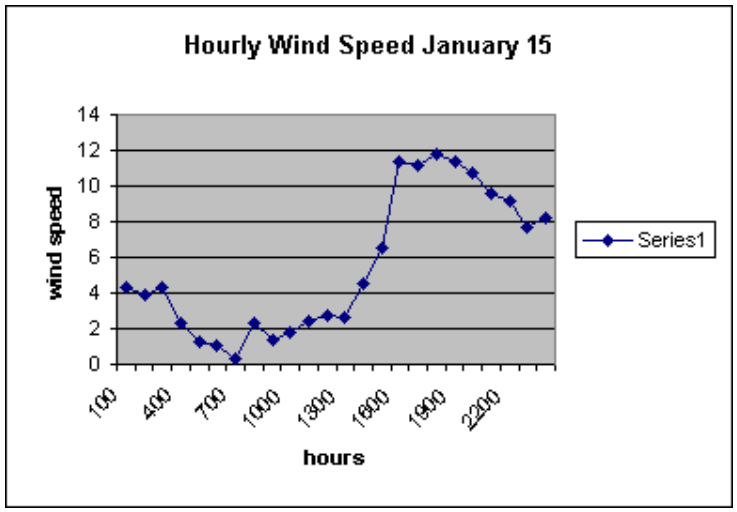
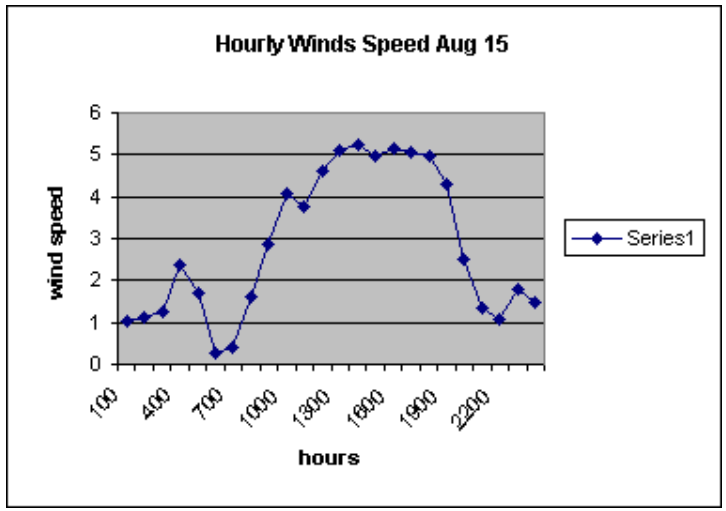
IDI
VILLAGE
(3)



High season



Low season

ANNEX 6
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GIZGIZA VILLAGE (1)

MONTHLY AVERAGE WIND SPEED AND DIRECTION OF GIZGIZA

	2000		2001		2002		2003	
	speed	***direction***	***speed***	***direction***	***speed***	***direction***	***speed***	***direction***
JANUARY	6,4224	48,538	6,4695	46,622	6,1654	50,916	6,123	56,522
FEBRUARY	7,0705	47,88	6,7818	50,056	6,1063	55,898	5,9327	55,45
MARCH	6,9829	49,722	5,0057	57,308	5,4865	58,84	5,6693	56,199
APRIL	5,4622	48,884	6,2551	51,273	6,876	54,705	6,1514	56,881
MAY	5,6485	43,594	5,2091	44,925	5,103	54,82	5,1144	54,786
JUNE	5,3661	242,77	5,8348	242,59	N/A	N/A	5,9796	252,22
JULY	5,1379	40,11	7,1133	238,2	6,7162	244,97	7,5907	241,96
AUGUST	6,2626	40,359	N/A	N/A	6,9649	242,51	6,7616	242,64
SEPTEMBER	6,3643	41,682	N/A	N/A	4,2603	49,392	4,4038	283,57
OCTEBER	5,0789	37,373	5,4363	52,717	5,8672	55,461	5,8688	34,966
NOVEMBER	4,425	30,234	6,0147	56,6	6,0134	57,573	5,8043	38,111
DECEMBER	2,1868	328,98	6,1828	55,393	5,8921	54,08	5,8845	38,296
Annual	**6,1411**	**41,831**	**6,0499**	**50,397**	**5,9599**	**51,522**	**5,9409**	**36,053**

N.B. Wind speed in m/s while direction is degrees.x mean there is no data.

Station Height= 10 m

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GIZGIZA VILLAGE (2)

Hourly Wind Speed in Gizgza for 15th of Every Month for the year 2000

HOUR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
100	6,1187	6,8202	3,9378	5,3353	0,958	1,1528	5,5957	6,331	5,2607	5,8942	2,4858	0,5605
200	5,8263	5,804	4,8203	6,0553	0,75533	3,3342	5,492	5,7105	5,3875	4,4885	0,69933	0,27483
300	6,6875	5,2288	6,7673	6,61	0,72567	5,1405	4,9108	5,667	4,283	4,001	0,9045	0,914
400	6,9265	6,727	7,0515	5,873	0,6785	6,7718	5,4063	5,9498	4,0293	5,9527	1,2932	1,5588
500	6,5558	7,2905	7,5383	4,87	0,27933	6,518	6,0763	5,8807	5,0218	6,1343	0,7175	1,942
600	6,1237	6,3428	7,8188	5,9675	0,66733	6,9053	7,1765	6,5975	4,8063	5,0718	1,3653	2,5985
700	6,4737	6,5995	6,446	4,1813	4,6602	6,8852	9,4583	6,7708	5,6368	4,942	1,2538	3,1238
800	6,5742	6,3178	5,213	1,8565	4,5755	7,3527	9,1633	6,3818	4,9798	5,774	0,28117	4,4287
900	6,6215	6,4692	6,4865	1,5965	4,5652	8,0267	9,1017	5,7952	4,8048	6,7738	0,62467	6,1107
1000	6,4248	7,0642	7,6548	4,4303	4,7212	5,4793	7,8783	5,9087	4,1172	7,91	0,86567	6,0558
1100	5,3793	8,19	7,2575	4,0152	3,9973	5,691	7,777	4,3318	5,2863	6,5213	1,1443	6,1862
1200	5,2945	8,2933	8,5417	2,0492	4,2663	5,9775	6,6992	4,4857	4,731	3,3987	2,3557	6,6018
1300	5,877	8,965	7,4707	2,8748	4,5998	5,514	8,4567	6,2975	3,0547	1,7997	3,969	7,855
1400	6,468	8,9633	8,955	4,9237	2,9132	5,022	7,6278	5,1367	2,207	1,6698	3,4717	7,9197
1500	6,5392	9,455	9,3367	3,8228	2,5878	5,5845	7,4843	4,6917	6,2675	1,3718	5,6652	9,33
1600	7,3323	9,05	9,6267	5,5072	5,2007	10,002	7,1205	3,1973	7,4097	2,2582	7,0427	9,6083
1700	7,6117	9,1183	9,2183	9,3933	5,9235	8,0585	3,926	3,8327	7,2193	5,481	7,6933	8,3917
1800	7,4333	8,74	8,495	7,5888	6,3982	6,4777	4,3287	2,8015	6,6887	8,67	6,5717	7,685
1900	7,7317	8,1367	8,1783	6,7423	7,9583	2,8145	8,084	6,9718	5,9395	6,3105	5,95	7,1288
2000	6,4473	7,59	7,6317	6,8872	6,962	2,6388	8,1555	6,9287	3,3143	1,0548	5,6872	7,2843
2100	5,987	7,6333	7,2622	4,8222	5,4222	2,5033	7,1255	6,0807	1,9618	2,3683	4,582	7,1157
2200	5,7127	7,7883	6,1242	3,102	4,6873	1,3742	8,9767	5,1932	3,7048	2,7225	4,5082	7,3578
2300	4,7763	7,3063	6,3183	5,47	3,7515	2,9683	9,51	6,0035	4,361	4,3607	3,6315	6,261
2400	3,8307	7,5733	5,8857	6,5853	1,5287	3,0612	8,1595	6,0825	3,4925	3,349	1,5232	5,902

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