TECHNICAL SPECIFICATIONS

Appendix A:
Technical Specifications
(Health Clinics)

DRAFT September 05 - 2006

Appendix A:
Technical Specifications
(Health Clinics)

DRAFT September 05 - 2006

Table of Contents

Table of Appendices

1 Introduction

This purpose of this tender is to electrify 50 health clinics sites in the regions of Niassa and Tete. The electrification is based solely on stand-alone solar photo-voltaic.

Design, supply and installation, commissioning of the equipment and training of local staff are included in the scope of works.

2 Scope of Works and Supply

2.1 To be Provided by the Contractor

The stand-alone solar photovoltaic system shall be implemented on a turnkey basis and single responsibility basis.

For each Health Clinic the following solar PV systems shall be implemented:

- System H-HC-II: Health Clinic Type II
- System H-SH : Staff house.

Each site contains a Health Clinic Type II. Two staff houses per site shall be electrified.

The project site data is available in Appendix 2.

The H-HC-II system shall as a minimum comprise:

Solar PV system
Photovoltaic array
Charge controller
Battery
Wires, fuses, switches, plugs, earthing
Structures

DC appliances for the health clinic:

DC appliances	Quantity	DC load Power W	Hours of use/day	Days per week	Energy load Wh/day	Amp-Hour load @12 V Ah/day
General lighting	6	8	5	7	240	20
Examination light	2	18	2	7	72	6
Outdoor lamp	1	8	8	7	64	5,3
Vaccine Fridge including outlet	1	60	18	7	1,080	90
Outlet for HF radio	1	25	18	7	450	37,5
Outlet for TV (14")	1	33	2	7	66	5,5
TOTAL DC					**1,975**	**165**
Corrected)**						**198**

***) *Battery efficiency factor of 85 %, wire efficiency factor of 98 %*

The H-SH systems shall as a minimum comprise:

Solar PV system	Unit	Quantity
Photovoltaic array	W_p	60
Charge controller	ud	1
Battery	ud	1
Wires, fuses, switches, plugs, earthing	ud	1
Structures	ud	1

DC appliances	Quantity	DC load Power W	Hours of use/day	Days per week	Energy load Wh/day	Amp-hour load Ah/day
General lighting	2	8	5	7	80	6,7
Reading light	1	18	3	7	54	4,5
Outdoor lamp	1	8	8	7	64	5,3
DC outlet	1	15	3	7	45	3,8
TOTAL					**243**	**20,3**
Corrected*						**24,4**

*) *Battery efficiency factor of 85 %, and wire efficiency factor of 98 %.*

The scope of works and supply shall include the following:

- Site surveys;
- Project engineering and detailed design of the system;
- Project management;
- Supply, installation, supervision, testing and commissioning of all equipment and materials;
- Training in operation and maintenance of local staff;
- Documentation, including a manual;
- Any other works and supplies which are deemed necessary for the completion of stand-alone solar photovoltaic.

2.2 To be Provided by the Employer

The following will be provided by the Employer:

- Equipment rooms or other available space (ready for installation) for the supplied equipment;
- Roof area, façade area or ground area for the solar photovoltaic array.

For each project site, a local staff member will follow the installation at all times, and is to be training in daily maintenance of the systems during the installation.

3 General Information and Requirements

3.1 Introduction

This section describes the general requirements of the Works and Supply. Particular technical requirements for equipment and accessories are described in the respective sections.

3.2 Existing Situation

The present situation at all sites is described in The Project Site Data attached as appendix to the bidding documents.

3.2.1 Electricity and Water

No electricity supply is available at the sites. Water may need to be transported several kilometres.

3.2.2 The Project Area

The project area is the region of Niassa and Tete. The area is shown on the map enclosed in Appendix 1.

3.3 Site Surveys

The Contractor shall carry out a site survey for all sites and verify/update the data given in these bidding documents.

During the detailed site survey phase, the Contractor shall liaise with the Employer to identify the infrastructure, i.e. the locations of the PV array, the equipment room and the DC appliances.

3.4 Detailed Design and Engineering

The work shall include the Contractor's detailed design needed to manufacture

- Calculation and specification of the solar PV system;
- Calculation and specification of structures of the PV array. Wind speed to withstand: 120 km/h.

The design of the solar PV system shall be based on the following assumptions:

- Number of no-sun days: 3 (H-SH), 5 (H-HC-II)
- System availability : 95% (H-SH); 99,9% (H-HC-II).
- Average annual horizontal solar radiation : 5,2 kWh/day/m^2 (Niassa) and 5,8 kWh/day/m^2 (Tete). Source : INAM – National Institute of Meteorology);
- Discharge rate of battery: C20.

The detailed design shall be approved by the employer before installation works is initiated.

3.5 Completeness of the Supply

All services, apparatus, accessories and installation materials which may not have been specifically mentioned, but which are usual or necessary in the respective materials/ equipment for the completeness of the finished plant and equipment in an operational status, shall be deemed to be included in the supply and shall be provided by the Contractor without any extra charge.

3.6 Standards and Recommendations

All components, materials and equipment shall be designed, manufactured and tested in accordance with the relevant sections of the latest editions of the standards and regulations mentioned below. If the product bears the PVGAP mark no further test certifications are needed.

- National Standards;
- PVGAP
- ITU-R (CCIR) recommendations;
- ITU-T (CCITT) recommendations;
- ISO Standards;

- IEC61215:1993 Crystalline Silicon Terrestrial PV modules
- IEC 61427 Secondary cells and batteries for solar PV energy systems.
- IEC60904-1 Photovoltaic Devices Part 1
- IEC61829: Crystalline silicon PV array
- IEC60896: Stationary lead acid batteries
- IEC60335: Safety on Household and similar appliances
- ETSI/ CENELEC Standards;

In addition hereto, the plant and equipment shall comply with other specific standards/recommendations and regulations as stipulated in the other sections of these bidding documents.

3.7 Installation and Supervision

The installation and supervision of the equipment shall be carried out by the Contractor on a turn-key basis.

All installation drawings, work procedures and methods required to ensure the proper installation and alignment of the equipment shall be provided.

After completion of the installation work, the Contractor shall restore the site to its initial condition.

3.8 Test

The contractor shall in collaboration with the employer perform a test of two of the first systems installed. The test shall be performed for at least 2 days and include monitoring of the solar insulation, energy output from the solar panels and total consumption in the period. The details of the monitoring as well as selection of the sites for monitoring shall be agreed with the employer before the test. The contractor shall provide documentation for the test as agreed with the employer.

3.9 Site Acceptance Test

Upon installation and commissioning, the system shall be inspected, and a Site Acceptance Test (SAT) shall be carried out by the Contractor

The results of the test shall be documented using the Site Acceptance Test Sheets enclosed in Appendix 4. The test results shall be handed over to the Employer.

3.10 Training

Training of one local staff member of each project site in relation to repair, maintenance and operation of the equipment shall be conducted by the Contractor.

The staff member shall follow all steps of the installation. During the installation the contractor shall go trough the *entire* "End-user manual" and the "Technician's Manual for Installation, Operation and Maintenance" (see section 4.11.2) when appropriate during the installation.

4 Technical Specifications

4.1 Photovoltaic Modules

Crystalline modules are required and shall comply with relevant PV GAP standard is PVRS 2 "Crystalline silicon terrestrial Photovoltaic (PV modules)". Te design qualifications and type approval of the PV modules shall comply with IEC 61215 "1993 Crystalline Silicon Terrestrial PV modules."

The deviation of electrical parameters from the nominal values by the manufacturer must not exceed:

- Nominal power : -10% to +20%
- Short circuit current : 15% to +20%
- Open circuit voltage : -10% to +15%

The encasing of the modules is done in category IP55 in relation to EEC/IEC 1215.

The PV shall be able to withstand temperatures between 0°C to 85°C.

The solar power systems shall consist of solar cells/modules and charge controller connected to batteries of nominal voltage of 12 V. 24V is allowed for the systems containing refrigerators or TV.

The solar modules shall be mounted on a roof or on the ground, with roof mounting as first priority. The orientation of the PV array is due north. In case due north is not possible, an orientation ±25° from north is acceptable. The slope of the PV modules shall between 15-35°. The slope must not be below 15° due to the self-cleaning.

The backside of the PV modules shall be freely ventilated. Roof mounted PV modules shall be mounted at a distance of at least 7 cm from the backside of th

The PV modules shall be situated so that there will be no shading from trees, antennas, other building parts, etc. onto the PV modules.

Each PV modules shall be clearly marked with the text indicating that the modules belong to MISAU.

A blocking diode is required between the PV array and the charge controller.

A circuit breaker is required between the PV array and charge controller for the purpose of maintenance.

4.2 Battery

The battery shall be of the type "deep cycle" with flooded lead-acid electrolyte. The battery shall be manufactured for the purpose of PV systems. and sealed maintenance-free battery with no topping up requirements.

The battery's nominal Depth of Discharge - at 2000 operation cycles - shall be between 35% and maximum 60%. During operation, the Depth of Discharge must not exceed the battery's nominal maximum Depth of Discharge.. The design should be based on maximum Depth of Discharge.

The battery nominal capacity (at C20) shall be

$$C = \frac{CorrectedDailyLoad * N}{DoD}$$

Where

C	is the capacity, Ah
CorrectedDailyLoad	is the average corrected daily load, Ah/day
N i	s the number of autonomy days, decimal number
DoD	is the actual rated Depth of Discharge of the battery, decimal number.

The working temperature is between 0-55°C. The self-discharge of the battery at 25°C must not exceed 6% of the rated capacity per month.

Batteries shall be supplied complete with accessories. The battery shall be delivered and installed in a well-vented battery enclosure that prevents users from coming in contact with battery terminals or battery electrolyte. The enclosure must be made of acid resistant materials.

For a flat plate battery shall comply with IEC Standard 61427 IEC:2001 Ed.2 "Secondary Cells and Batteries for Solar Photovoltaic Energy Systems - General Requirements and Methods of Test". The battery capacity should be at least 100% of the nominal C20 capacity after the "5th C20-test" and it should be at least 95% of the nominal C20 capacity after the "6th C20-test"

4.3 Charge Controller

Charging of the batteries shall be controlled automatically with the following features:

- Temperature compensated charging through an external probe;
- Function in accordance with Pulse Width Modulation (PWM) or On/Off;
- Overcharge protection. High Voltage Disconnection (HDV) must be at the battery end voltage that correspond to 0% of the Depth of Discharge (DoD);
- Over-discharge protection, e.g. by disconnecting the load;
- Series charge controller with solid state relay;
- Protection against reverse polarity must be provided in both the PV modules and battery lines;
- Reserve leakage current must be less than 500 micro-Amperes (current from battery to "dark" module);
- Deep discharge protection. Low Voltage Disconnection (LVD) must be at the battery end voltage that correspond to maximum allow Depth of Discharge (DoD).

The charge controller must support at least 25% more than the nominal current.

The battery consumption voltage drop must be under 0,5 V. The input battery drop must be under 0.5 V.

The voltage drop across the Charge Controller when charging or discharging should be less than 5% of the nominal system voltage.

The controller shall function in the range of 0-50°C, and must withstand at least 90% of rated current from the PV module to battery and from battery to load at this temperature interval.

The controller shall not be installed in the battery enclosure (battery box).

4.4 Cables

The contractor shall include 75 m of cable per solar photovoltaic system in his offer. Final payment will be adjusted according to actual

$$S = \frac{0{,}3 * L * I_m}{\Delta V}$$

where

S	is the cross section, m^2
L	is the cable length, m
Im	is the maximum current, A
ΔV	is the maximum allowed voltage drop, %

The maximum allowable value of voltage drop (ΔV) must be less than

- 5% between the Charge Controller and the DC load
- 3% between the PV modules and the Charge Controller
- 3% between the Charge Controller and Inverter
- 1% between the Charge Controller and the Battery

All cables used outdoor shall be UV-resistant and waterproof.

Cables must be colour coded in accordance with the existing electric coding norms.

4.5 Switches, Sockets and Protection

DC sockets must be used with reverse polarity protection. DC fuses and circuit breakers must be rated for DC service. The equipment shall be rated at least 20% more than the design voltage and current.

Allow for one socket per room.

4.6 Grounding (earthing)

All metallic enclosures and structures of the system must be bonded and grounded using the shortest practical route to an adequate earth contact using an uninterrupted conductor of at least 16 mm^2 cross-section.

The maximum allowed earth resistance must be 10 Ohms with the maximum bonding resistance (between the metal parts of the devices and metal parts of the consumer earth terminal) of 0.2 Ohms.

The maximum allowable earth resistance between consumer and earth terminal to earth spike must be 1.7 Ohms, including earth electrode.

Support structures must be made of stainless steel, aluminium or galvanized iron, and must be able to withstand wind speeds of 120 km/h so as to be able to resist at least 20 years of outdoor exposure without suffering significant damage or corrosion.

4.7.1 Fence

If the PV modules are placed on the ground fencing shall be delivered and installed. Assume that 40% of systems will be situation on the ground. No any specific specifications in respect of the fencing.

4.8 Appliances

4.8.1 Compact Fluorescent Lamp (CFL) and Tubular Lamp (TL)

All general and outdoor lighting shall be of the type CFL or TL.

Luminous yield of the total ballast and fluorescent lamp system must be al least 35 lumens/Watt. Ballast must ensure safe and regulated ignition within 10 seconds in the voltage range from 10.3 to 15 V over 0 to +45°C. Minimum electrical efficiency of the ballast should be 80% in the voltage range from 10.3 to 15 V.

The electrical waveform at the fluorescent lamp terminal must be symmetric in time to within 10 percent (i.e., 60%/40% waveform maximum differences in symmetry over voltage range of 11.0 to 12.5 Vdc at an ambient temperature of 25°C).

There must be no blackening or reduction in the output (reference Lux) by more than 10%, observed after 1,000 on/off cycles, and the lamp must still be operational after 5,000 on/off cycles.

- General use: Wide angle with high luminance (330 to 370 lumen);
- Localised use: Narrow angle with medium to high luminance (180 to 220 lumen);
- Luminous yield of the total ballast and fluorescent lamp system must be at least 35 lumens/W.
- Task specific use: Work specific, for example dim light.

The DC component of the current through the fluorescent lamp should be zero.

A suitable filament pre-heating circuit should be provided. The lamp should be protected against reverse polarity.

Standby consumption (in no-tube condition) of ballast should be less than 10% of rated capacity.

4.8.2 LED Cluster Lamp

Reading light shall be of the type LED.

Power consumption must be less than 2 Watt/cluster. LED clusters must operate flawlessly at voltages between 10.3 to 15 V and temperature from 0°C to + 45°C.

To protect eyes from intense light, a white LED cluster should shine through a solid angle of at least 45°, for proper diffusion.

4.8.3 Refrigerators

The system shall include refrigerator and freezer (loaded and including icepack freezing).

The total size of the refrigerator shall be more than 58 litres (vaccine room and icepack freezing).

The refrigerators shall operate from a separate battery set. The charge regulator shall always give priority to recharging the refrigerator battery set.

The internal temperature of the refrigerator shall remain within the range of 0°C to +8°C.

The load of standard icepacks containing water at the ambient test temperature shall freeze in less than 12 hours and shall weight at least 2 kg, without the material of the pack.

The energy consumption of the refrigerator shall be less than 0.7 kWh/24 hours for appliances with a gross volume of less than 50 litres, and less than 0.1 kWh per additional 10 litres of gross volume, at 45°C with vaccine load, but without icepack freezing.

An alarm (red LED) shall be installed to warn that power to the compressor has been disconnected by the regulator. An alarm shall be fitted to warn to the user when the battery is in a low state of charge. The advance warning to the user (voltage threshold if voltmeter, or orange light if LED used) shall be clearly labelled "Do not freeze icepacks" in an appropriate language. An external

materials. Ten spare fuses shall be provided in a polyethylene bag fixed near any fuse box.

The refrigerators shall be CFC free.

4.9 Spare Parts

The Contractor shall compose and deliver an optimal package of spare parts equal to 2,5 % of the Contract sum. The spare part package shall minimum include the following items.

Item
PV modules
Batteries
Battery interconnects
Battery fuse
Charge controller
Inverter
Wiring
Indoor lights
Exterior lights
Appliances
Distilled water

4.10 Warranty

The following warranties shall be issued by the Contractor:

- 20 years for PV modules. The power output after 10 years shall be at least 90% of the nominal power and at least 80% after 20 years;
- 2 years for the Charge Controller;
- 5 years for batteries;
- 2 years for all other parts of the PV system, including all DC appliances.

4.11 Documentation to be Provided

The following information shall be delivered for **each** solar PV system:

PV modules

- Brand and name of the manufacturer
- Model and type
- Manufacturer's serial number of the system indicating the year of manufacturing
- Rated peak Watt per module
- Maximum Rated Current
- Maximum Rated Voltage
- Short Circuit Current
- Open Circuit Voltage
- Quantity of modules
- Total installed nominal power, W_p

Battery

- Brand and name of the manufacturer
- Model and type
- Rated capacity in Ampere-hours at the discharge rate C20
- Quantity of batteries
- Total installed rated capacity (C20), Ah.

Charge Controller

- Brand name
- Type (On/Off or PMW) and model
- Maximum input current
- Maximum load current
- Nominal voltage
- Size of fuses
- Quantity

DC appliances

- Brand name
- Type and model
- Nominal power in Watt
- Nominal voltage
- Size of fuse (s).
- Quantity of appliances.

Other component

- List of other components (wires, switches, fuses, outlets, grounding, etc.)
- Name, model and type
- Quantity.

Drawings
Schematic of the solar PV system.

4.11.2 Documentation after Award of Contract

The documentation to be supplied after award of Contract shall include:

- Detailed design documentation including installation drawings;
- End-user manual;
- Technician's Manual for Installation, Operation and Maintenance.

Detailed Design Documentation
The documentation shall include specifications and calculations, which shall be submitted in 2 copies to the Employer for approval **no later than 1 month** after the signing of the contract. A period of 2 weeks shall be allowed for the Employer's examination and approval of this documentation.

The documentation to be prepared by the Contractor in connection with the detailed design shall be sufficiently detailed for the purposes of:

- Assembly and erection details of solar panels arrays;
- Erection drawings for all other equipment;
- Calculation of battery capacities and charger ratings;
- Schematic diagram of generating set control;
- Detailed schematic diagrams of DC supply, its distribution and supervision with accompanying description;
- Layouts and detailed drawings of cables etc.;
- Layout drawings of earthing system;
- Layout drawings of lightning protection system.

End-user Manual
The End-user Manual shall include:

- Theory of operation of the SPVS with a discussion on: battery charging by the array; functions, battery low voltage protection and battery overcharge protection. The relationship

- Procedures for proper system operation, including a list of load limitations and any problem loads. Suggested operation, including load conservation during periods of inclement weather and/or a low voltage disconnect event. The procedures for that checking the photovoltaic array is not shaded and how to prevent shading must be explained;
- Any user maintenance items;
- Procedures for emergency shut-down and for extended periods of system non-use;
- A trouble-shooting guide for users.

Technician's Manual for Installation, Operation and Maintenance
The technician's manual shall include:

- A complete list of all system components, with associated manufacturers literature, specifications and warranties;
- Complete installation instructions;
- Installation protocol with the initial start-up numbers from the approval test and general measurement values
- Explanation to the user of the system operating principles, load management requirements, impact of shading of the array and how to check and avoid it, user maintenance checks and how to conduct them;
- A recommended annual maintenance schedule, with complete maintenance instructions;
- A detailed trouble-shooting guide referencing all the system components. This shall include repairs and diagnostic procedures that can be done by the supplier or a qualified third party. Repairs and procedures not to be attempted by non-electricians and/or electricians unfamiliar with photovoltaic systems shall also be identified;
- A functional block diagram, electrical single-line drawing showing the placement of all hardware and ratings of all components and physical layout;
- Emergency shut down procedures.

The Contractor shall supply documentation in the form of manuals and all
essary documentation