TETRA TECH

complex world | CLEAR SOLUTIONS™

Association of Public Health Laboratories, APHL

Assessment of Backup Power Needs for Selected Laboratories in Mozambique

Final Report v.1.0

October 19, 2010

Association of Public Health Laboratories, APHL

Assessment of Backup Power Needs for Selected Laboratories in Mozambique

Final Report v.1.0

October 19, 2010

Prepared for: APHL

Tetra Tech
4601 North Fairfax Drive, Suite 601 | Arlington, VA 22203
Tel 703.387.2100 | Fax 703.387.2160
www.tetratech.com

10/20/10

TABLE OF CONTENTS

EXECUTIVE SUMMARY

A Tetra Tech energy team visited Mozambique to assess the energy situation in 8 medical laboratories at the request of the Association of Public Health Laboratories (APHL). In particular, the team was asked to focus on ways to ensure both quality and reliability of the available electricity. The laboratories in question are: the Central Hospital laboratories in Maputo (Microbiology, Biochemistry, and INS Immunology and Virology Reference Lab); and laboratories at the Ministry of Health, Mavalane Hospital and the Military Hospital in Maputo, as well as at the Xai Xai and Quelimane Provincial Hospitals.

The team visited and undertook a variety of data gathering exercises at each of the laboratories (except Quelimane, in which the assessment was carried out remotely), including:

- Measurement of voltage and power, both instantaneous and recorded over a period of hours
- Inventory of laboratory instruments and equipment, along with nameplate electricity data; identification of “contact” and “no-contact” loads
- Inspection of the laboratory and its surroundings, including standby generator
- Interview with laboratory management staff.

As a result, the following points summarize the team’s findings:

- Power outages do not seem to be a serious problem in Maputo; in the provinces power cuts appear to be more likely, at times even programmed.
- Laboratory staff seemed to be very concerned about having proper backup power systems, regardless of type.
- Voltage variation is higher than expected –measurements in Maputo showed variations of as high as 6.5%.
- Electrical connections are on average in reasonable condition, but no separate identification of circuits is available at the panels.
- Many computers and sensitive instruments have individual UPS systems installed; however, all are beyond their performance age, and have not been maintained.

The team’s recommendations are to install high quality (double conversion) UPS units on all “no-contact” loads, and voltage regulators on “contact” loads, in both cases counting on the standby generator to be turned on within a few minutes of a grid power failure. Instruction manuals and training programs must be developed to ensure the sustainability and reliability of this effort, especially since the double-conversion UPS units are relatively new to Mozambique.

Tables of installation costs and maintenance costs are provided for all types of backup power systems, providing background information for decision-making and allowing comparison of costs among the different available systems.

Although grid power is generally available in the main cities and towns, and its cost is extremely low, a short analysis of the applicability and cost-effectiveness of solar PV installations is also provided in the report.

1. BACKGROUND AND CONTEXT

1.1 OBJECTIVE

Tetra Tech was hired by the Association of Public Health Laboratories (APHL) to assess the energy situation at the most important laboratory facilities in Mozambique and to recommend appropriate backup power installations, taking into account cost and reliability. Although the electricity supply in the main cities of Mozambique is for the most part stable, the high cost of sensitive laboratory instruments typically requires surge protection, voltage regulation and accommodation for backup power.

Tetra Tech set out to determine the required backup power system requirements and sizing (inverters, batteries, regulators, uninterruptible power systems, emergency generators, and/or auxiliary equipment) for each laboratory. The objective was to provide initial estimates of installed costs, and to develop specifications describing the recommended equipment, wiring and installation instructions, such that APHL may use this information to receive quotations and/or to contract the installations.

The main criterion in the field work was to collect sufficient data to is to ensure high quality of the energy to power the equipment of the laboratory; high quality means constant voltage and constant frequency or maximum variations of 2% for each and no black outs during the work hours, at least.

1.2 FACILITIES VISITED

The scope of the project was limited to laboratory installations at the following sites.

Central Hospital – Microbiology Lab: small laboratory in the main hospital in Maputo, operating 40 hours per week.

Central Hospital – Biochemistry Lab: medium-sized laboratory in the same main hospital in Maputo.

INS Immunology and Virology Reference Lab: this crowded, medium-sized laboratory is also located in the main building of the Central Hospital in Maputo.

DNAM – Ministry of Health: a medium-sized research laboratory located on the premises of the Ministry of Health central building in Maputo.

Mavalane General Hospital: the laboratory of a good-sized full-service hospital located near the outskirts of Maputo.

Military Hospital: this medium-sized laboratory in the hospital located in Maputo is a sprawling installation spanning about 6 large rooms,

Xai Xai General Hospital: – this small laboratory is part of the main hospital in the provincial capital city of Xai Xai, approximately 3 hours drives from Maputo.

Quelimane Hospital – very small laboratory in a provincial capital city (recommended to travel by air) (due to time constraints and distance, this hospital was not visited. However, the Tetra Tech team was able to use the telephone to obtain layout and operations data as well as an equipment inventory. We were told that the electrical conditions are similar to those at Xai Xai.

1.3 TYPES OF ELECTRICAL LOADS

The concern of health laboratories is to ensure that “critical loads” can be stably maintained in the face of unreliable or poor quality electric power. Critical loads are those loads that are crucial to the operation of a facility and must continue to be available when grid or generator power (primary power) goes out. These loads need to be connected to some type of backup power system to ensure extended operation without primary power. For health facilities, these typically include: lighting, laboratory instruments, emergency room, operating room, night lighting, vaccine, sample and reagent refrigerators and freezers, and computer and information systems equipment. Air conditioners, heaters and other heavier loads, such as autoclaves, are not usually considered to be critical.

Critical loads are further subdivided into two types: contact loads and no-contact loads:

> “Contact loads” are those critical loads for which the quality of electrical energy and the transfer time from the primary source of energy to the back-up source are not critical factors. Quality of electricity implies minimum voltage fluctuation with pure sine wave variation. Transfer times for these loads can take more than a second without affecting the performance of the loads. These loads can be connected to a back-up battery/inverter system that is automatically connected when the primary power goes out.
>
> “No-contact loads” are those critical loads for which electrical quality is paramount, and which require uninterrupted transfer between the primary and back-up sources of energy. These loads must be permanently connected to a battery/inverter system which provides continuous high quality power (constant voltage and perfect sine wave), even when the primary power is cut.

1.4 TECHNICAL APPROACH

The Tetra Tech team applied the following approach consistently to all of the facilities visited.

- Interview with the laboratory director, or person in charge to: explain objectives and activities; obtain permission for photos and data retrieval; and request explanations of any problems or issues with electricity, including surges, power failures, or other effects on the instruments and laboratory operation.

- Measurement of electric power to the laboratory, where possible. This measurement was taken over a period of hours by connecting an electronic logger to the wiring in the electrical panel. The result provided a confirmation of the instantaneous load in the laboratory, as well as its variation over time. Variations in voltage were also logged.

- Inventory of major equipment in the laboratory. Each load is identified, along with its full-load nameplate amperage or wattage. In addition, the loads are identified as “contact” or “no-contact” according to their sensitivity.

- Inspection of the surrounding hospital area, including location and state of the emergency generator.

All of the information gathered is organized and documented on standard Energy Assessment Forms that Tetra Tech uses in typical energy analyses of health facilities. These are provided in full detail in Appendix C.

1.5 FINDINGS

The on-site measurements, interviews and observations of laboratory operation lead to the following summary of findings.

- Power outages do not seem to be a serious problem in Maputo. In fact, in most laboratories, the staff could not remember the last power outage. In other cases, there were vague references to short power outages (10-15 minutes), but without any certainty or evidence. In the Central Hospital, the backup generator has run only 316 hours in more than 2 years, most of it due to weekly testing of the backup system.

- Nevertheless, laboratory staff seemed to be very concerned about having proper backup power systems, regardless of type. This may be more of a legacy of past years, when apparently there was some uncertainty, rather than a current problem.

- Outside Maputo, in Xai Xai and Quelimane, there is some evidence that power cuts are more frequent, at times even programmed

- Voltage variation does appear to be higher than expected – our measurements in Maputo showed variations of as high as 6.5%. Most equipment and instruments will withstand variations of up to 10%, but this indicates that attention should be paid to voltage variations.

- Electrical connections are on average in reasonable condition. However, no separate identification of circuits is available at the panels, so some effort will be required to develop separate circuits for no-contact and contact loads.

- Many computers and sensitive instruments have individual UPS systems installed; these were likely installed with each instrument when new, likely at least several years ago. All of the UPSs observed are the basic systems, which offer 15-20 minutes of backup power (when new), and which have not proven to last more than 2 years without battery replacement. On a number of these units, the indicator lights were not functioning properly; others were showing a full battery charge when the experience in the laboratory was that the UPS did not last more than a few minutes. No one seems to do anything about maintaining these units, although some of the staff recognize that the batteries need regular replacement. We suggest that these UPS systems offer a false sense of security, since in fact they are beyond their useful life.

- In some cases, we noted basic UPS systems installed on refrigerators (Central Hospital labs). Such an installation is not warranted, since the UPS will provide a maximum of 15-20 minutes of backup power when new, and only a few minutes after a year or two of use (without battery replacement). These few minutes are not useful to the proper operation of a refrigerator, which can keep its temperature for 15-30 minutes without additional power. In cases where there is an emergency generator, there is even less reason to invest in a UPS for a refrigerator or freezer application.

- If the UPS system was installed for purposes of voltage regulation, that is not a proper application either. Although UPS manufacturers claim voltage regulation is built into their systems, this function is not as high quality as that provided by a dedicated voltage regulator. (Only in the case of a double conversion UPS, where all the power is coming through the battery, would we consider that the UPS provides sufficient voltage regulation. However, none of the UPS observed in Mozambique were of this higher quality type.) We also noted some equipment connected to both a voltage regulator and a UPS, an installation that the UPS manufacturer does not recommend.

These findings provide the basis of the discussion on recommendations in the next section.

2. SYSTEM SIZING AND COSTS

2.1 IMPROVING THE QUALITY AND RELIABILITY OF ELECTRICAL ENERGY

We have concluded the best way to improve the quality and reliability of energy in Mozambique's hospitals is by using UPS systems in conjunction with emergency generators. Another possible solution is by means of a solar system, we have included a solar system sizing for the Xai Xai hospital as an example (see Appendix B).

Voltage regulators and UPS are available in almost all countries and there are a number of manufacturers, a number of size and capacities depending on the loads and quality of energy required.

Because all of the hospitals are connected to the grid, the best way is to regulate the voltage and using a big one UPS instead of a number of small ones UPS.

2.2 SUMMARY OF POWER AND ENERGY DEMAND

Exhibit 2.1 presents the summary of maximum loads, both "contact and no-contact per site as well as the total value. The value of power corresponds to the maximum considering all equipments running simultaneously; this condition is both rare and unlikely, however we have taken that value as the nominal capacity of the UPS and/or regulator.

Exhibit 2.1 Laboratory Power Demand Comparison

	Contact Loads	No-Contact Loads	Total Load	
Laboratory Facility	**kW**	**kW**	**kW**	**no-contact load ratio**
CENTRAL HOSPITAL – MICROBIOLOGY	18,590	2,040	20,630	10%
CENTRAL HOSPITAL – BIOCHEMISTRY	27,065	17,438	44,503	39%
INS IMMUNOLOGY AND VIROLOGY REFERENCE LAB	28,990	14,881	43,871	34%
DNAM MINISTRY OF HEALTH	25,574	3,065	28,639	11%
HOSPITAL GENERAL MAVALANE	29,094	8,275	37,369	22%
HOSPITAL MILITAR	22,911	10,302	33,213	31%
HOSPITAL GENERAL XAI XAI	16,608	5,369	21,977	24%
HOSPITAL QUELIMANE	1,500	4,150	5,650	73%

2.3 ANALYSIS OF ALTERNATIVES TO IMPROVE THE RELIABILITY AND QUALITY OF ELECTRICAL ENERGY

Following are descriptions of common technologies available to improve the quality and reliability of electrical energy, each developed to satisfy particular needs.

1) **Battery/Inverter** systems are often used due to their capacity to withstand hard conditions. They are modular and can be designed to sizes of 10 kW and more, usually limited by the number and capacities of batteries. These are heavy duty, usually robust pieces of equipment with a very high reliability in the field, used mostly where grid electricity is not available or the service is very limited; rural environment meaning dusty, high level of humidity among other is the type of environments where they work. This technology has evolved and improved with its use in solar PV systems.

   Battery/inverter systems can be used for both “contact” loads (loads are normally on grid or generator power and automatically transfer to battery operation if power is cut or power quality is compromised), as well as for “no-contact” loads (these loads are connected permanently to the inverter providing perfect sine wave current fed by the batteries, which are charged by grid or generator power – hence the term “no-contact:” the loads always see high quality battery power and are never exposed to grid or generator power).

2) **Uninterruptible Power Systems (UPS)** are very common in industries, institutions and even homes, basically for computers, servers and other IT equipment. The typical UPS is designed to provide 15-20 minutes of backup power when primary power is cut or compromised in quality. This is typically sufficient time to properly power down IT systems. However, it may not be sufficient to maintain the integrity of tests run on some laboratory instruments.
   Day by day the UPS industry is growing and the manufacturers have developed higher quality and higher capacity models, along with increased periods of back up time. However, UPS are available in different levels of quality, and it is important to evaluate and carefully determine what one is buying. The typical UPS models used for home and office computers operate similar to the “contact” loads in the battery/inverter application: when power is cut or compromised, the UPS switches to battery operation. Higher quality, “double conversion” UPSs are designed to connect to “no-contact” loads, with all input power going through the internal battery and inverted to perfect sine wave output, i.e., high quality power. This effect also maintains the voltage at stable level with no spikes.

   A possible downside to the UPS installations is the quality of the batteries. For typical “contact” UPS systems, these batteries may last up to 2 years. However, the new double conversion UPS systems come equipped with no-maintenance batteries that last 5 years, or even 10 years.

One limitation of the UPS systems is the relatively short backup period, or autonomy. These systems are typically designed with a 20-30 minute time period, although many offer options to install additional batteries to double this period of time. Still, these systems will not usually be able to provide much more than one hour of autonomy. Only a large battery bank with a battery/inverter system is able to cost-effectively provide long periods of autonomy. On the other hand, if a facility has a working emergency generator, an autonomy of more than a few minutes is not necessary, since as soon as the generator comes on, it will begin to charge the batteries of the UPS. Meanwhile the loads will continue to see high quality current from the inverter output.

3) **Voltage regulators** are very useful where the quality of the electricity is poor, especially where surges or large variations in voltage or frequency are experienced. Good voltage regulators correct both voltage variations and frequency variations. However, these regulators are only good when power is available – they offer no backup capability. Thus they are limited to “contact” loads when a high quality of energy is needed with no backup requirement. For “no-contact” loads, the voltage regulation is taken care of in the battery/inverter system, or in the double conversion UPS.

4) **Inertia wheels** are basically UPS, they are spinning wheels that store energy, thus replacing the battery bank. They require very little maintenance and are easy to operate and maintain. Their use is not yet widespread, however. One of their main limitations is the size range, the smallest available is around 15 kVA and the largest is 50 kVA. While initially more expensive than battery/inverter systems, they are very competitive in terms of net present cost and their life cycle cost per kVA.

5) **Engine generators**, often referred to as backup generators or emergency generators are extremely useful for backup power due to the fact that they are available in much higher capacities than batteries, inertia wheels, or solar PV systems. However, they are also limited to providing backup to “contact” loads, which can accept the slight delay or dip in power when the generator is started either automatically or, in many cases, manually. While automatic transfer time is typically less than 100 milliseconds, sensitive IT equipment and laboratory instruments may not survive this (these are “no-contact” loads). In the case of a manual transfer, the time is likely to be up to several minutes. Even a manually switched generator can work adequately with most “contact” loads, and can effectively support a double conversion UPS or battery/inverter system, since in both cases , the battery will continue to provide power during the period when neither grid nor generator is operating.

2.3.1 Criteria for service

Exhibit 2.2 provides a summary comparison of the characteristics and needs of the critical loads found in health laboratories in Mozambique.

Exhibit 2.2 Characterization of Critical Loads

ATTRIBUTES	CONTACT LOADS	NO CONTACT LOADS
High quality of energy	Preferable	Required
Transfer time to emergency power	Not critical	Critical
Autonomy, hours (time during which backup power is available)	Variable, from few minutes to one hour maximum	Variable, 8 hours maximum for Mozambique
System reliability	99 %	>99 %
Monitoring	Not necessary	Recommended

2.3.2 Comparison of Backup Power Technologies

The chart in Exhibit 2.3 provides a summary comparison of the characteristics and applications of different backup power technologies.

2.4 INVESTMENT SCENARIOS

We have prepared different installed cost estimates in order to provide some comparative data and try to facilitate the decision process. We suggest the following considerations as input to the decision.

- Battery/inverter systems are essentially a heavy duty UPS; we suggest these might be overkill in the context of the systems we have evaluated in Mozambique. Their higher cost and increased maintenance requirements do not seem to be warranted in the facilities we assessed.
- Small UPS for refrigerators have a very low impact in terms of backup power (even when new), and but they are questionable as a voltage regulation device.
- Voltage regulators will “clean” the electrical power but do not provide backup power.
- The UPS seems to be the best option despite the fact that costs of O&M is high due the battery bank replacement. However, any installation of new UPS should be accompanied by a primer, an instruction manual and a maintenance schedule in Portuguese, along with some training of local technicians.

Exhibit 2.3 Comparison of Power Quality and Backup Power Technologies

PARAMETER	INVERTER AND BATTERIES	UPS	VOLTAGE REGULATOR	INERTIA WHEELS	DIESEL GENERATOR
Availability in Mozambique	100%	100%	Yes	Not currently, but possible	100%
Feasibility to be supplied to Mozambique	100%	100%	100%	100%	100%
Country of Origin	USA	Several	Several	Mexico, others	Several
Investment ranges	$1.4 to $2.4 US$/Watt Installed (Batteries included)	$0.18 to $1.1 USD / VA	$0.07 to $0.5 USD/ VA	$1.6 to $3.5 USD/VA Installed	$140 to $300/kW depending on size
O&M	$300 USD/year and battery replacement every 5 to 8 years	$500 USD/year and batter replacement every 5 or 10 years		$ 500 USD/year maximum	$1.2 to $3.8 USD/kWh depending on size
Skilled labor for installation	Yes	Not always	Yes	Yes	Yes
Skilled labor for operation and Maintenance	No	No	No	No	Yes
Capacities available	1.3 to 2.16 kW modular (capacity as rectifier)	0.5 to 160 kVA	1 to 2000 kVA	10 kVA to 1000 kVA	1.5 KVA to 4000 KVA
Back up time (Range)	Depending on design. From minutes to hours and days	Depending on design. From minutes to hours and days	Zero	Indefinite	Indefinite
Robustness	Heavy duty	Moderate	Moderate	Heavy duty	Heavy duty
Withstand the humidity with no condensations	Yes	Yes	Yes	Yes	Yes

PARAMETER	INVERTER AND BATTERIES	UPS	VOLTAGE REGULATOR	INERTIA WHEELS	DIESEL GENERATOR
Clean room requirements	No	No	Possibly	No	No
Monitoring including	Limited – not remote monitoring not logging long periods of time	Optional	Optional	Yes	Optional
Expected Life time	20 years (with battery maintenance and replacement)	10 years (for double conversion)	15 years	24 years	20 Years
Warranty period	10 years	1 year	2 years	10 years	1 year
Voltages available	120, 220	120, 220	120, 220	208 to 4160	all
Frequency (HZ)	50 and 60 Hz	50 and 60 Hz	60 Hz	50, 60, 400 Hz	50, 60
Output voltage variation	+/- 2% for "no-contact" loads	+/- 2% for double conversion units	+/- 3% to 4%	+/- 1%	+/- 3% to 4%
Harmonics variations	2% to 4%	2% to 3%	< 0.4%	1.4%	2% to 4%
Efficiency of rectifier side (battery charger)	60%	60%	N.A.	N.A.	N.A.
Inverter efficiency	92%	95-97%	98% a 99%	N.A.	N.A.

- Inertia wheels are effectively UPSs also, although the initial investment is higher than for the traditional or high quality UPS systems. However the longer backup time and the voltage regulation function and the lack of batteries to replace, make this an option that is worth considering in the future. Drawbacks are high initial cost, no experience with such systems in the country, and minimum size of at least 10-15 kVA, meaning that only central installations are possible, that individual equipment installations are not an option.

- Engine generators, while adequate for "contact" loads, also have an important role to play for "no-contact" loads: where a generator is available, the battery backup in the UPS need only provide sufficient power to cover the period of the transfer – once the generator is running, it can charge the batteries and the no-contact loads are assured constant, high quality power.

Given that most of the laboratories assessed have emergency generators for backup power, our recommendation is that APHL procure and install new double conversion UPS units for each of the laboratories. Along with this procurement, we suggest the following: purchase of extended warranties; implementation of a formalized maintenance and testing program; development of instructional and guidance materials for ongoing maintenance of these systems; and formal training of local technical staff.

The UPS installation could take one of three formats:

a) A single, double conversion UPS per laboratory, centrally located and wired into the electrical distribution system for the whole laboratory. All laboratory equipment, whether "contact" or "no-contact" would be wired to this system.
b) A single, double conversion UPS for each laboratory, centrally located and sized to cover "no-contact" loads only. A separate circuit of electrical outlets would be installed and connected to the UPS; only "no-contact" loads would be plugged into these outlets.
c) Individual, double conversion UPS systems would be installed for each instrument or for each instrument group (main analyzer, related equipment, computer/monitor, printer, etc.).

Exhibit 2.4 provides a comparison of the merits and drawbacks of these three different UPS installations. Our recommendation is to carry out installations according to option b) above and in Exhibit 2.4. It should be noted that in all cases, a working backup generator must be present to provide power when grid power is not available for more than several minutes. (Such a generator exists at all of the sites visited in Mozambique, except for the military hospital and the DNAM installation at the Ministry of Health.)

Exhibits 2.5 and 2.6 present comparative costs for different backup power technologies, providing a comparative glance at the relative costs of the various options.

Exhibit 2.4 Considerations for UPS Installation Options

(based on double-conversion UPS)

(backup generators are required for power failures greater than several minutes)

	a) One central UPS for the whole lab	**b) One central UPS for "no-contact" loads only**	**c) Multiple small UPS installed on individual loads**
Installation	Hard-wired at the panels supplying all laboratory circuits	Hard-wired at panels, but with separate installation of receptacles for "no-contact" loads	UPS plugged in to existing receptacles; loads plugged into UPS
Advantages	Simplest and most rapid installation solution; all of the laboratory instruments and equipment are protected	Less costly than a) since it is focused on "no-contact" loads only, typically 10-40% of the total lab load	Less costly than a) and provides greater redundancy than b), since any UPS failure will affect only one instrument
Disadvantages	Highest cost; why pay for extra capacity, especially if "no-contact" loads are only 10-20% of the total load; also, no redundancy in case of UPS failure	Requires running additional circuitry and receptacles in the lab; may require relocating some lab instruments; lack of redundancy as in a)	Many UPS units can cause clutter; possible slight increase in maintenance costs
Other considerations	"No-contact" loads are taken care of.	May need to consider installation of voltage regulators for "contact" loads	Can possibly use larger plug-in UPS, and include more than one instrument on each. May still need voltage regulators on "contact" loads.
Example: Hospital General Mavalane	Total load, 50 kVA: $35,000	"No-contact" loads, 15 kVA: $ 10,000; + separate no-contact receptacle lines $3,000; total $13,000	Separate UPS for "no-contact" loads; 10 @ 1.5 kVA: $ 16,000

Exhibit 2.5 Price Comparison: Voltage Regulation, UPS, Inertia Wheels

	Total Load	Sizing	Voltage Regulator	UPS – one-hour backup		Inertia Wheels
Laboratory Facility	**kW**	**kW**	**Investment**	**Battery Size, VAh**	**Investment**	**Investment**
CENTRAL HOSPITAL – MICROBIOLOGY	20,630	25	$4,600	34,560	27,300	45,000
CENTRAL HOSPITAL – BIOCHEMISTRY	44,503	50	$10,500	51,840	48,500	90,000
INS IMMUNOLOGY AND VIROLOGY REF. LAB	43,871	50	$10,500	51,840	48,500	90,000
DNAM MINISTRY OF HEALTH	28,639	30	$7,000	34,560	32,000	65,000
HOSPITAL GENERAL MAVALANE	37,369	40	$8,500	51,840	40,000	90,000
HOSPITAL MILITAR	33,213	35	$7,500	34,560	36,000	65,000
HOSPITAL PROVINCIAL XAI XAI	21,977	25	$5,500	34,560	27,500	45,000
HOSPITAL QUELIMANE	5,650	10	$2,500	17,280	13,000	40,000
Totals			$56,600		272,800	530,000

Exhibit 2.6 Prices for Battery/Inverter System

		Battery / Inverter System -- 1 hour backup			
	Total Load	**Inverter**	**Rectifier**	**Battery Size**	**Investment**
Laboratory Facility	**kW**	**kW**	**kW**	**VAh**	**US$**
CENTRAL HOSPITAL – MICROBIOLOGY	20,630	14.4	3.6	34,560	28,000
CENTRAL HOSPITAL – BIOCHEMISTRY	44,503	25.2	14.4	51,840	56,000
INS IMMUNOLOGY AND VIROLOGY REF. LAB	43,871	25.2	10.8	51,840	52,000
DNAM MINISTRY OF HEALTH	28,639	18	3.6	34,560	32,000
HOSPITAL GENERAL MAVALANE	37,369	21.6	7.2	51,840	44,000
HOSPITAL MILITAR	33,213	21.6	7.2	34,560	40,000
HOSPITAL PROVINCIAL XAI XAI	21,977	14.4	7.2	34,560	32,000
HOSPITAL QUELIMANE	5,650	3.6	3.6	17,280	12,000
Total					296,000

2.5 INVESTMENT REQUIREMENTS FOR UPS AND REGULATORS – OPTION B

We recommend that APHL consider Option b) of Exhibit 2.4 since it appears to be most economical, reliable and feasible to implement in the short time. UPS are the key component for Labs in Mozambique. Exhibits 2.7 to 2.9 show the final analysis that includes the UPS, regulators and O&M costs for each site.

Exhibit 2.7 shows the investment for double conversion UPS considering an extended backup of an additional 30 minutes to the regular back up time; UPS are considered just for no-contact loads only. This action implies new conduits and outlets in laboratories (a relatively minor cost, not contemplated in Exhibit 2.7.

Exhibit 2.7: Investment for UPS by Site

SITE NAME	NO CONTACT LOADS		UPS (0.25 hours of backup at total load))			
	Wh	W	kW	+ 30 MIN BACK UP	UPS INVESTMENT	TOTAL INVESTMENT
CENTRAL HOSPITAL - MICROBIOLOGY	15,450	2,040	2	$377	$3,276	$3,653
CENTRAL HOSPITAL - BIOCHEMISTRY	110,392	17,438	20	$3,226	$21,840	$25,066
INS IMMUNOLOGY & VIR. REF. LAB	92,791	14,881	15	$2,753	$16,380	$19,133
DNAM MINISTRY OF HEALTH	22,385	3,065	3	$567	$3,931	$4,498
HOSPITAL GENERAL MAVALANE	54,850	8,275	10	$1,531	$13,000	$14,531
HOSPITAL MILITARY	64,488	10,302	10	$1,906	$13,000	$14,906
HOSPITAL GENERAL XAI XAI	36,176	5,369	5	$993	$6,552	$7,545
HOSPITAL QUELIMANE	24,900	4,150	5	$768	$6,552	$7,320
TOTAL				$12,121	$84,531	$96,652

For the contact loads, we consider that an investment of voltage regulation systems will provide the necessary protection to the instruments and equipment. Exhibit 2.8 summarizes the investment in voltage regulators for the contact loads. These regulators should be installed close to the load center to regulate all the contact circuits in laboratories.

Exhibit 2.8: Investment in Voltage Regulators by Site

SITE NAME	CONTACT LOADS		VOLTAGE REGULATOR	
	Wh	W	kW	INVESTMENT
CENTRAL HOSPITAL - MICROBIOLOGY	127,634	18,590	20	$4,600
CENTRAL HOSPITAL - BIOCHEMISTRY	344,055	27,065	30	$7,000
INS IMMUNOLOGY & VIR. REF. LAB	273,474	28,990	30	$7,000
DNAM MINISTRY OF HEALTH	200,496	25,574	30	$7,000
HOSPITAL GENERAL MAVALANE	275,144	29,094	30	$7,000
HOSPITAL MILITARY	163,380	22,911	25	$5,500
HOSPITAL GENERAL XAI XAI	120,415	16,608	20	$4,600
HOSPITAL QUELIMANE	4,500	1,500	10	$2,500
TOTAL				$45,200

Exhibit 2.9: O&M costs for UPS and Regulators per site

SITE NAME	O&M COST FOR 10 YEARS		
	UPS	REGULATOR	TOTAL
CENTRAL HOSPITAL - MICROBIOLOGY	$3,821	$500	$4,321
CENTRAL HOSPITAL - BIOCHEMISTRY	$32,664	$500	$33,164
INS IMMUNOLOGY & VIR. REF. LAB	$27,874	$500	$28,374
DNAM MINISTRY OF HEALTH	$5,741	$500	$6,241
HOSPITAL GENERAL MAVALANE	$15,500	$500	$16,000
HOSPITAL MILITARY	$19,297	$500	$19,797
HOSPITAL GENERAL XAI XAI	$10,057	$500	$10,557
HOSPITAL QUELIMANE	$7,773	$500	$8,273
TOTAL	$122,727	$4,000	$126,727

Exhibit 2.9 shows the annual costs for operation and maintenance of the UPS and voltage regulators summarized in Exhibits 2.7 and 2.8. The UPS will require a battery replacement every 2-3 years, depending on the manufacturer's requirements (some manufacturers may provide a 5-year battery).

The voltage regulators do not normally require replacement parts but is recommended having a technician carry out an inspection and make adjustments at least once per year; this is not a high maintenance cost.

Exhibit 2.10 shows the total costs including capital costs and operations and maintenance costs for 10 years. These figures were calculated taking the costs of batteries and labor and inflation. Batteries should be replaced every two years.

Exhibit 2.10 Summary of Investment per Site

SITE NAME	TOTAL INVESTMENT COST			
	UPS	REGULATOR	O&M 10 years	TOTAL
CENTRAL HOSPITAL – MICROBIOLOGY	$3,653	$4,600	$4,321	$12,575
CENTRAL HOSPITAL - BIOCHEMISTRY	$25,066	$7,000	$33,164	$65,230
INS IMMUNOLOGY & VIR. REF. LAB	$19,133	$7,000	$28,374	$54,507
DNAM MINISTRY OF HEALTH	$4,498	$7,000	$6,241	$17,739
HOSPITAL GENERAL MAVALANE	$14,531	$7,000	$16,000	$37,531
HOSPITAL MILITARY	$14,906	$5,500	$19,797	$40,203
HOSPITAL GENERAL XAI XAI	$7,545	$4,600	$10,557	$22,702
HOSPITAL QUELIMANE	$7,320	$2,500	$8,273	$18,093
TOTAL	$96,652	$45,200	$126,727	$268,580

APPENDIX A: MEASUREMENTS OF VOLTAGE AND ELECTRICAL DEMAND

A.1 INTRODUCTION

The energy data presented below are the results of the electric energy quality measurements conducted in 5 hospitals in Mozambique. The data was collected using the Amprobe DM-III Multitest electric energy measuring instrument. The closest load center to the laboratory was identified, and current transformers and clamps were installed on each on each phase in order to measure real current, voltage and power demand.

Energy quality takes into account various factors and parameters which are not the focus of this study but that can assist us in proposing the best technologies for the hospitals and improve electrical service for power laboratory equipment. The voltage variations between phases over the course of several hours (relatively representative of what would occur over a longer period of time) provide a basic understanding of power quality.

A.2 PRESENTATION OF THE MEASUREMENTS

The information presented is voltage variations and power demand that were registered during a certain period of time and at the dates stated for each case. The graphics were produced by the Amprobe data software program.

Acceptable voltage variation should be less than 2% between phases but also for only one phase during a certain period of time. Other factors also assist in qualifying power quality such as frequency variations and harmonics. However, we consider that the voltage variation parameter is a good indicator to assist us in taking corrective actions.

A.3 MAVALANE

A.3.1 Voltage variations

Measurements were taken on August 24, 2010, from 1:20 PM to 3:03 PM. Results are summarized in Exhibits A.1 and A.2.

Exhibit A.1 Voltage variation summary at the Mavalane Hospital

	RMS Voltage PH 1	RMS Voltage PH 2	RMS Voltage PH3	% Variation (max.)
HIGH	227.3	224.8	225	1.100%
MEDIUM	226.4	224	224	1.060%
LOW	225.5	223	222.2	1.463%
% variation	0.7919%	0.8007%	1.2444%	

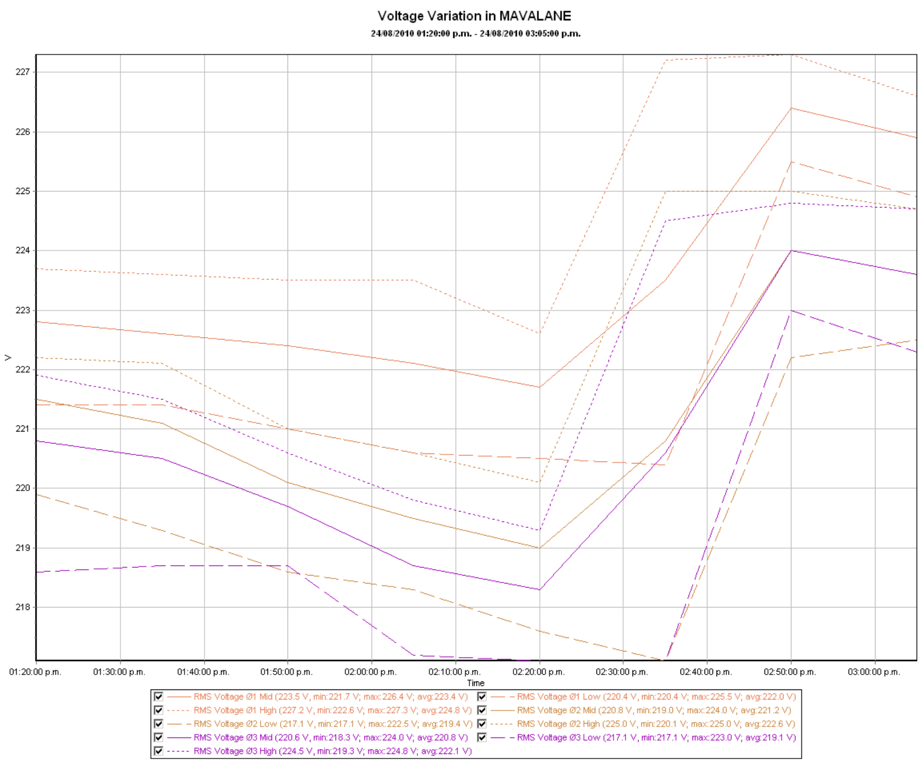

Exhibit A.2 Voltage variations at the Mavalane Hospital

A.3.2 Analysis of Results

Exhibit A.1 gives a summary of the data measured and indicates % variation of the voltages during the measuring period. In this table, we calculated the maximum variation percentage that resulted from the variation analysis between each phase and, in turn, between the maximum, average and minimum data values.

Exhibit A.2 shows the results as they were recorded by the measuring instrument. The lower part of the graphic shows the data table for the maximum, average and minimum values for each one of the phases.

In this specific case, the measuring results show that the voltage variations never went above 2%. Based on this, we observe that the voltage at the Mavalane hospital is within acceptable parameters.

Power demand, as shown in Exhibit A.3, was well balanced between all phases. The total data values we measured were: Maximum 6,227 W Phase I with a min. of 0.0W Phase 3 and an average demand of 7,879 W for all three phases.

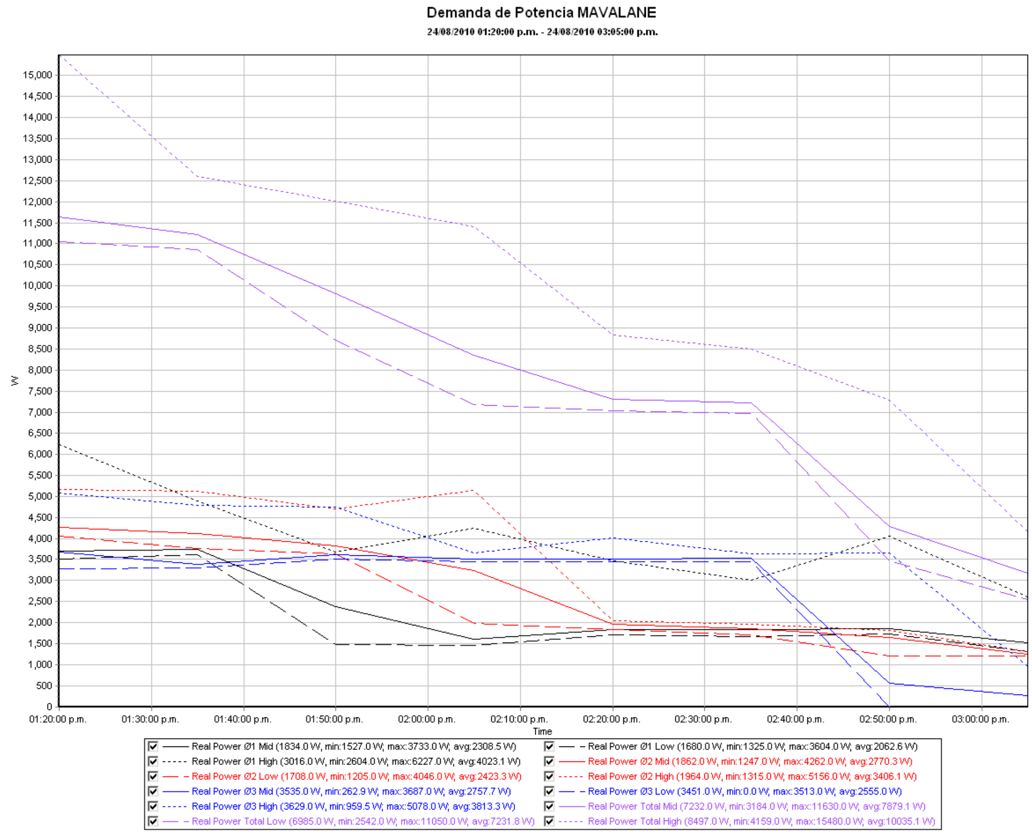

Exhibit A.3 Power Demand at the Mavalane Hospital

A.4 CENTRAL HOSPITAL – BIOCHEMISTRY

Measurements were taken August 25, 2010, from 12:53 PM to 2:08 PM. Results are presented in Exhibits A.4 through A.6.

Exhibit A.4. Voltage Variation Summary at the Central Hospital

	RMS Voltage PH 1	RMS Voltage PH 2	RMS Voltage PH3	% Variation (max.)
HIGH	231	231.4	231.4	0.000%
MEDIUM	229.3	229.1	229.8	0.087%
LOW	223.7	224.3	224.6	-0.134%
% variation	3.1602%	3.0683%	2.9386%	

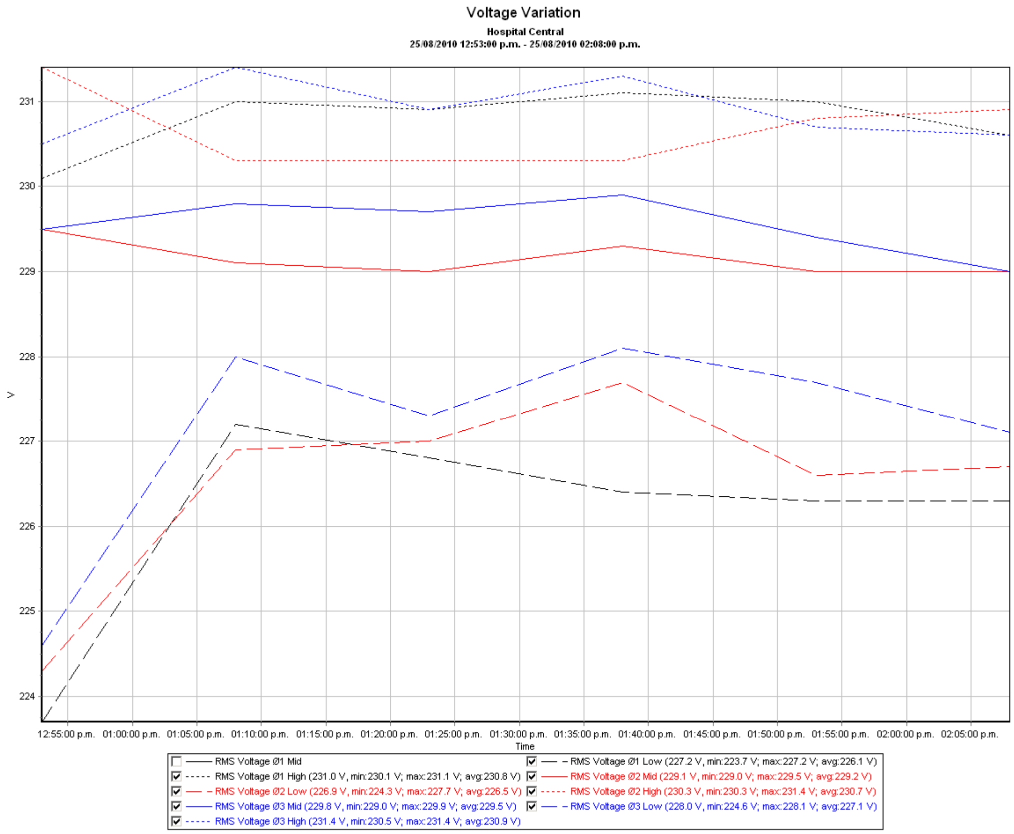

Exhibit A.5 Voltage variations at the Central Hospital

Exhibit A.4 provides a summary of the measured data and indicates % variation of the voltages during the measuring period.

Exhibit A.5 shows the results as they were recorded by the measuring instrument. The lower part of the graphic shows the data table for the maximum, average and minimum values for each of the phases. In this table, we calculated the maximum variation percentage that resulted from the variation analysis between each phase and, in turn, between the maximum, average and minimum data values.

In this specific case, the measuring results show that the voltage variations are as high as reach 3.16%, meaning that the hospital is beyond the acceptable voltage variation parameters of $\pm$ 2%. The voltage variations between phases were less than 1% which does not lead to any observation.

Power demand (Exhibit A.6) was well balanced between all phases. The total data values we measured were: Maximum 12,540 W Phase 3, with a min. of 1,140W Phase 2 and an average demand of 18,333.3 W for all three phases.

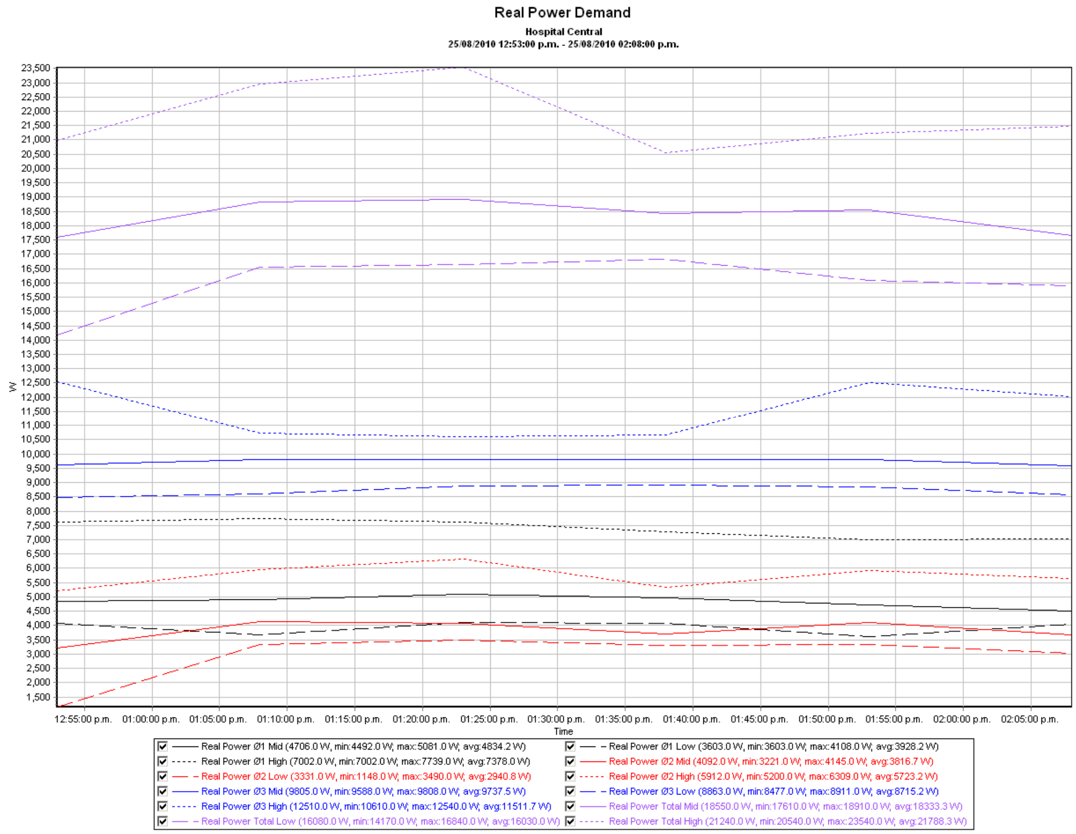

Exhibit A.6 Power demand at the Central Hospital

A.5 MILITARY HOSPITAL

Measurements were taken from August 26, 2010 2:39 PM to August 27, 2010; 8:19 AM.

Exhibit A.7 gives a summary of the measured data. It is important to note that the longer the measuring period, the better we can observe voltage variations. In this table, we calculated the

Exhibit A.7 Voltage variation summary at the Military Hospital

	RMS Voltage PH 1	RMS Voltage PH 2	RMS Voltage PH3	% Variation (max.)
HIGH	232.8	233.4	236.5	-0.258%
MEDIUM	223.2	222.1	222.8	0.493%
LOW	221.0	221.1	221.2	-0.045%
% variation	5.0687%	5.2699%	6.4693%	

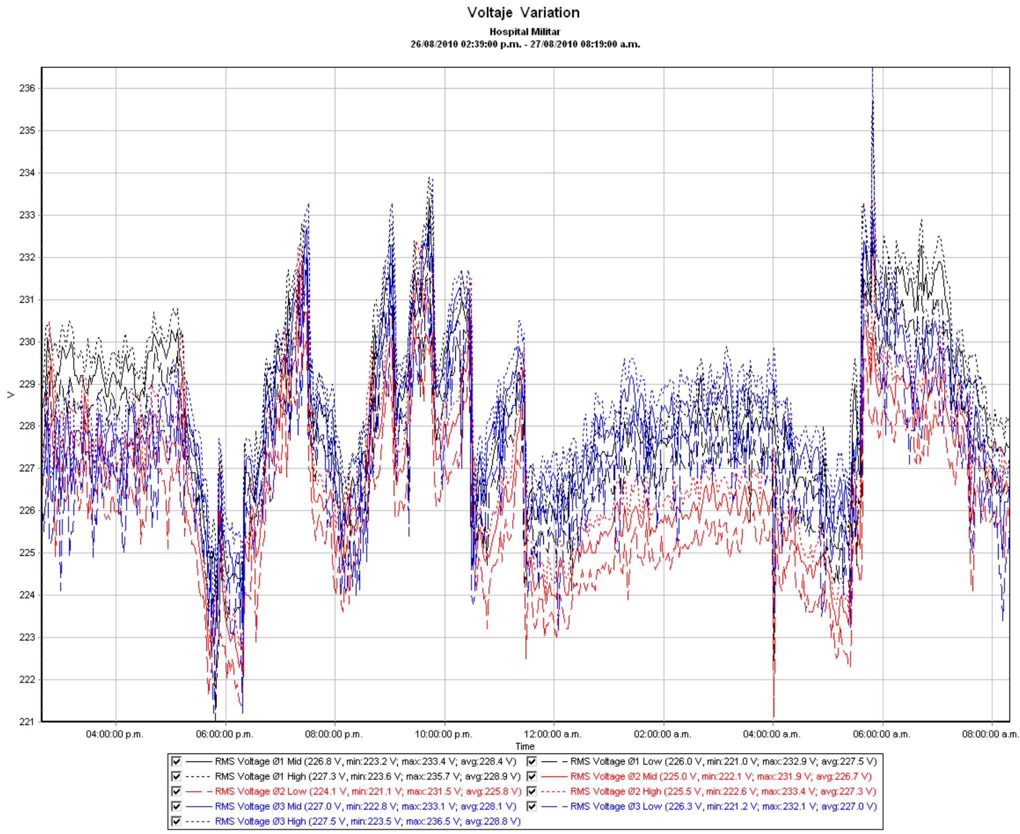

Exhibit A.8 Voltage variations at the Military Hospital

maximum variation percentage that resulted from the variation analysis between each phase and, in turn, between the maximum, average and minimum data values.

Exhibit A.8 shows the results as they were recorded by the measuring instrument. The lower part of the graphic shows the data table for the maximum, average and minimum values for each one of the phases.

In this specific case, the measuring results show that the voltage variations go well beyond 2% to reach 6.469%. We conclude that the hospital is beyond the acceptable voltage variation parameters. The voltage variations between phases were less than 1% which does not lead to any observation.

Due to the limited space available in the load center we were not able to measure any current values, so we are not able to present information on variation of power demand.

A.6 MINISTRY OF HEALTH, MOLECULAR BIOLOGY

Measurements were taken on August 30, 2010 from 11:01 AM to 12:05 PM.

Exhibit A.9 provides a summary of the measured data. In this table, we calculated the maximum variation percentage that resulted from the variation analysis between each phase and, in turn, between the maximum, average and minimum data values.

Exhibit A.9 Voltage variation summary at the Ministry of Health

	RMS Voltage PH 1	RMS Voltage PH 2	RMS Voltage PH3	% Variation (max.)
HIGH	224.3	226.3	226.8	-0.221%
MEDIUM	222.8	225.5	225.2	0.133%
LOW	220.5	217.9	217.6	1.315%
% variation	1.6942%	3.7119%	4.0564%	

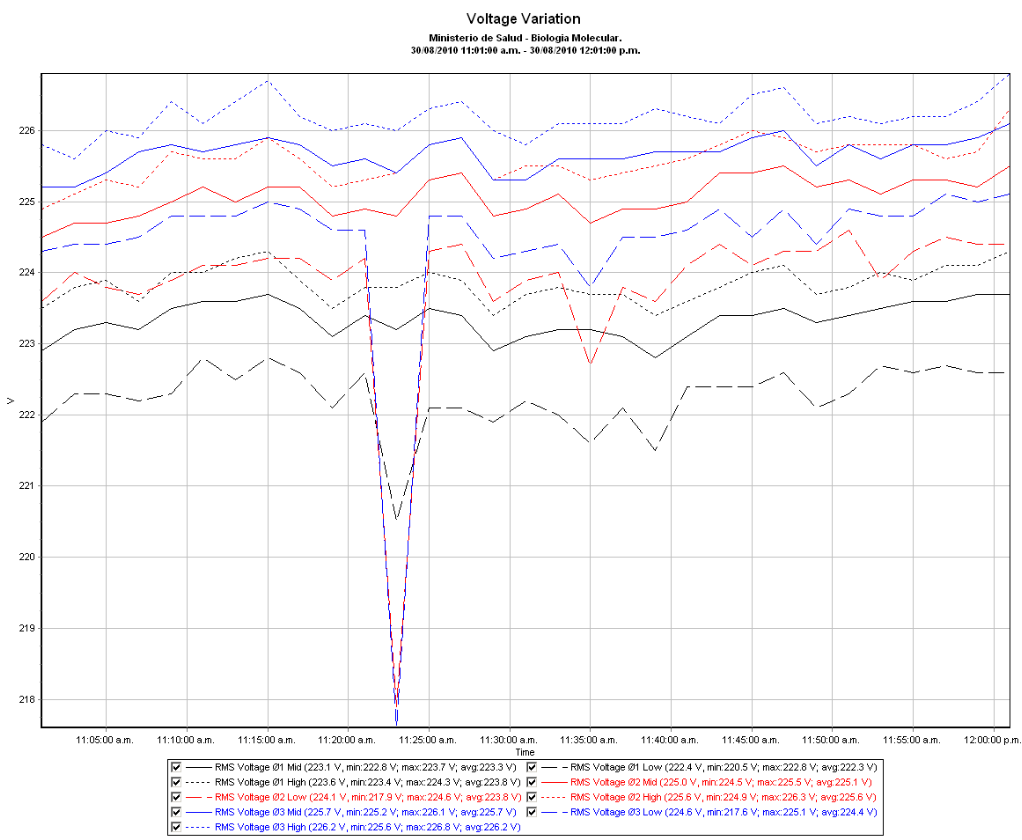

Exhibit A.10 Voltage variations at the Ministry of Health

Exhibit A.10 shows the results as they were recorded by the measuring instrument. The lower part of the graphic shows the data table for the maximum, average and minimum values for each one of the phases.

In this specific case, the measuring results show that the voltage variations go beyond 2% to reach 4.04%. We conclude that the hospital is beyond the acceptable voltage variation parameters. The voltage variations between phases were less than 1.5% which does not lead to any observation.

Exhibit A.11 shows that power demand was not well balanced between all phases. The total data values we measured were: maximum 4,994 W Phase 1 with a min. of 2,328 W Phase 1 and an average demand of 9,546 W for all three phases.

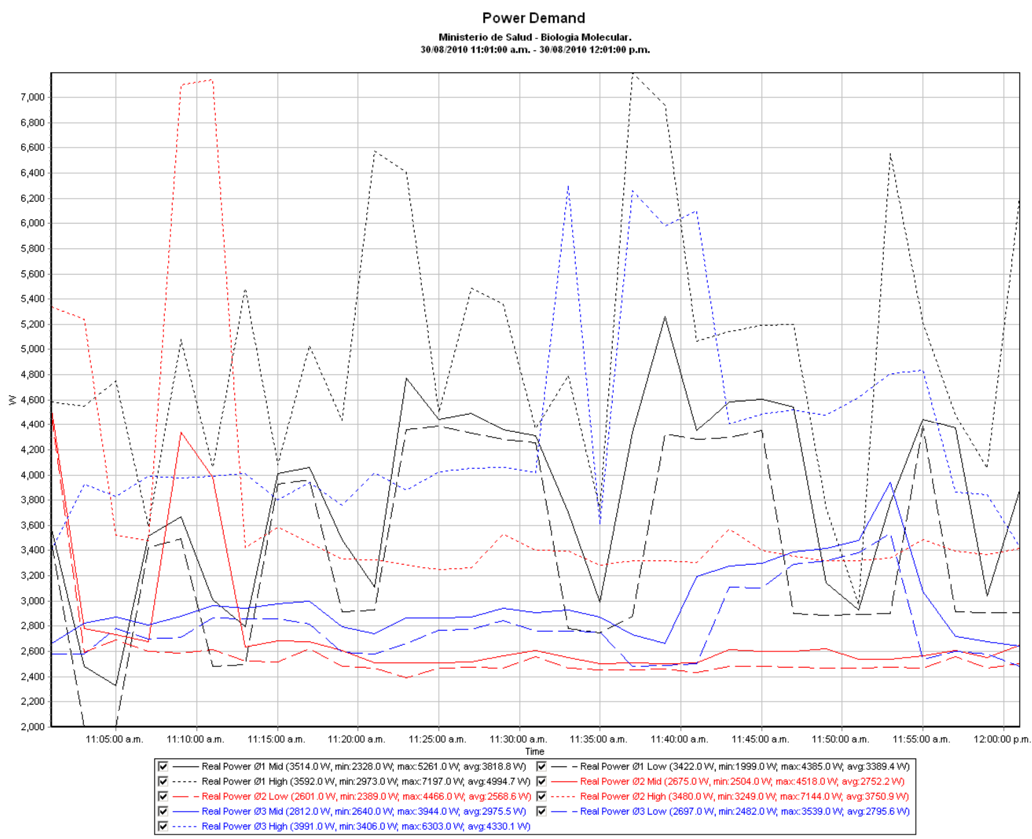

Exhibit A.11 Power demand at the Ministry of Health

A.7 XAI XAI PROVINCIAL HOSPITAL

Measurements taken on August 31, 2010 from 10:57 AM to 12:05 PM.

Exhibit A.12 provides a summary of the measured data. In this table, we calculated the maximum variation percentage that resulted from the variation analysis between each phase and, in turn, between the maximum, average and minimum data values.

Exhibit A.12 Summary of voltage variation in the Hospital Xai Xai.

	RMS Voltage PH 1	RMS Voltage PH 2	RMS Voltage PH3	% Variation (max.)
HIGH	232.2	235.3	230.9	1.870%
MEDIUM	228	231.5	227.2	1.857%
LOW	226.5	230.5	226	1.952%
% variation	2.4548%	2.0399%	2.1221%	

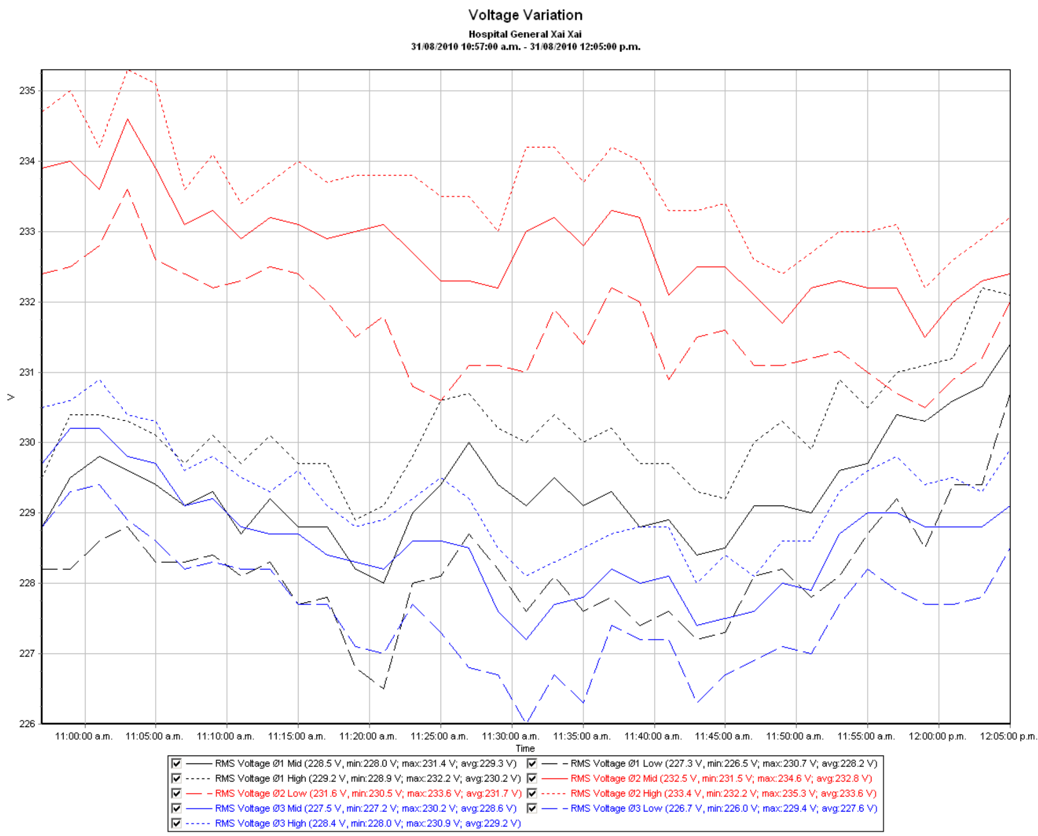

Exhibit A.13 Voltage variations at the Xai Xai Hospital

Exhibit A.13 shows the results as they were recorded by the measuring instrument. The lower part of the graphic shows the data table for the maximum, average and minimum values for each one of the phases.

In this specific case, the measuring results show that the voltage variations go above 2% to reach 2.45%. We conclude that the hospital is beyond the acceptable voltage variation parameters. The voltage variations between phases were less than 2% which does not lead to any observation.

Exhibit 14 shows that power demand was not well balanced between all phases. The total data values we measured were: maximum 6,781 W Phase 3 with a minimum of 1,071 W Phase 1 and an average demand of 11,940 W for all three phases.

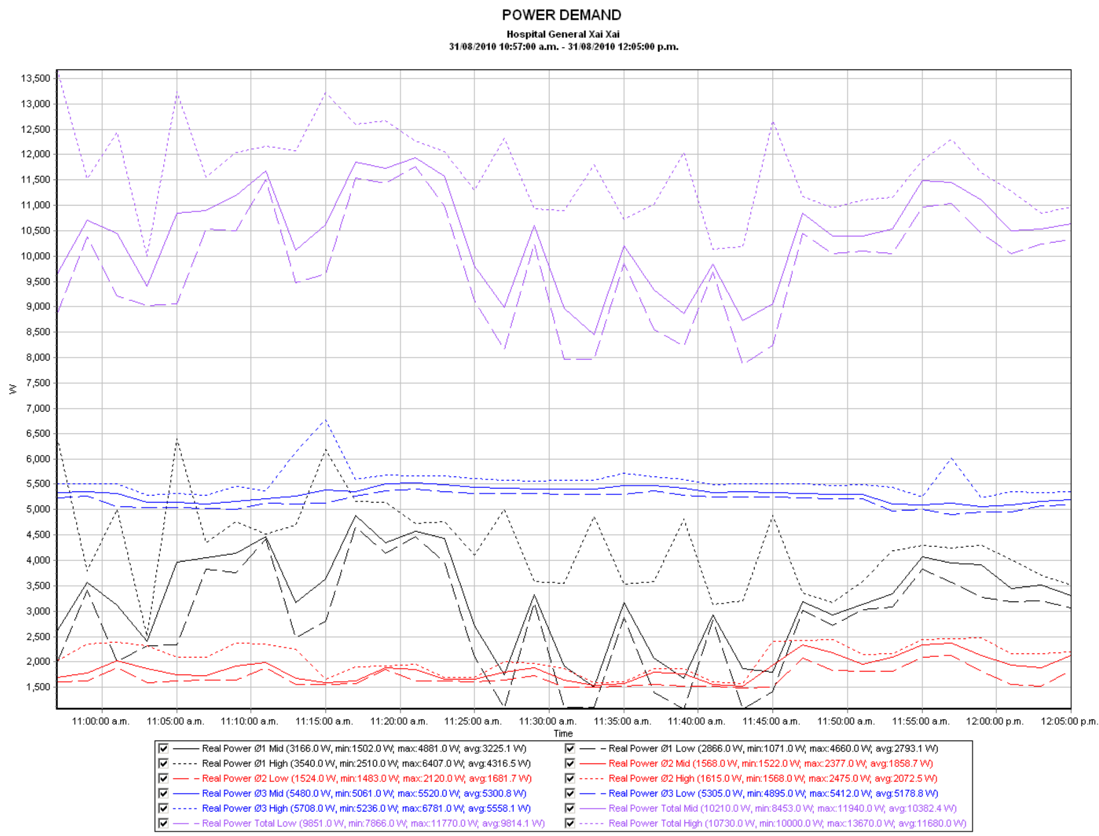

Exhibit A.14 Power demand at the Xai Xai hospital

APPENDIX B: **SAMPLE SIZING OF A SOLAR PV SYSTEM**

This section describes the sizing of a solar photovoltaic (PV) system that can provide complementary power to health facilities in Mozambique. Given the widespread availability, reliability and low cost of grid electricity in the country, this application is not immediately cost-effective in Mozambique. However, in provincial areas such as Xai Xai and Quelimane, a solar PV system could help improve the reliability of the energy supply, especially during the rainy season when it seems power cuts are more frequent.

B.1 OBJECTIVE

Provide an analysis of a representative solar PV-assisted back-up power system, along with approximate pricing that may be considered to complement the basic battery-inverter back-up power and no-contact systems.

B.2 INTRODUCTION

We have taken the Hospital in Xai-Xai as the model to size the solar system. The baseline for power and energy demand was obtained from assessment carried out the 30th of August, including the Amprobe monitoring system installed at the site during one work-hour.

B.3 POWER AND ENERGY DEMAND

The power demand in the laboratory in Xai Xai basically is divided in two levels: work hours (Monday to Friday from 7:00 to 15:00) and after work hours and weekends.

The maximum power demand during the monitoring was 13.5 kW, the average 10.38 kW.

We are considering the 10% of the average as the minimum load for after work hours and weekends; thus the daily average demand is around of 90 kWh/day.

The daily load profile considered is shown in Exhibits B.1 and B.2, and the monthly profile as Exhibit B.3.

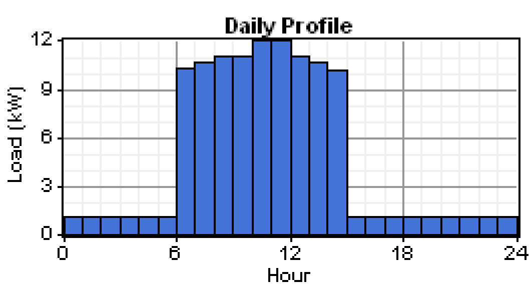

Exhibit B.1. Daily work days profile

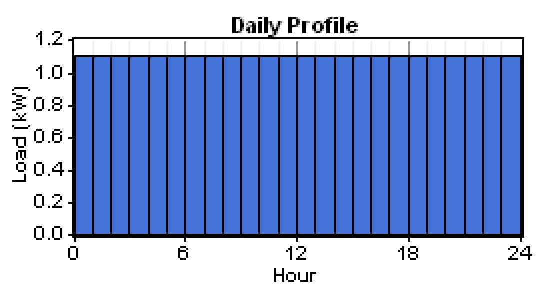

Exhibit B.2. After work hours and weekends profile.

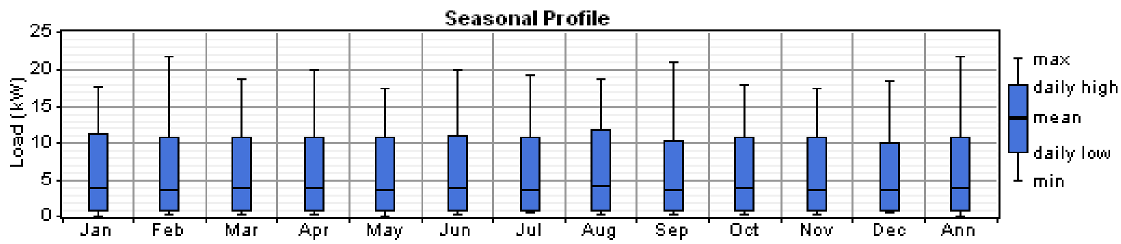

Exhibit B.3 Monthly load profiles.

B.4 SOLAR ENERGY RESOURCE

The solar energy resource in Mozambique is very good, having an average of 5.3 peak hours, meaning 5300 Wh/m^2-day of solar energy. The monthly solar profile is shown in Exhibit B.4.

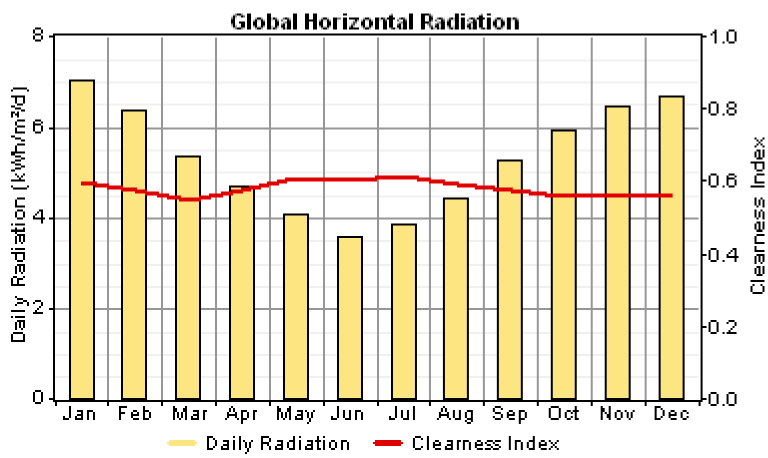

Exhibit B.4 Solar radiation and clearness index

B.5 PV SYSTEM COMPONENTS AND COSTS

The solar system will be comprised of the components listed in Exhibit B.5, and will be tied both to the grid and the diesel generator in order to charge the battery bank in case of high energy demand and/or low solar radiation.

The PV system will have 66 solar modules, 11 arrays of 6 modules each; voltage operation 48 DCV; total capacity 14.78 kW.

Exhibit B.5 Basic Elements of a 15 kW Solar PV System

Quantity	Item Description	Unit Cost	Extended Cost
66	Solar modules 224 Watts Sharp	$1,120.00	$73,920.00
11	Racks for 6 modules each w/hardware	$330.00	$3,630.00
2	Charge controller	$400.00	$800.00
5	Outback 3.6 kW inverter	$3,000.00	$15,000.00
8	Batteries Rolls 460 AH @ 100 hours	$550.00	$4,400.00
1	Load Center	$50.00	$50.00
1	Wires, protections and other electrical components	$700.00	$700.00
1	Shipping cost, duties and taxes	$11,820.00	$11,820.00
1	Labor	$5,910.00	$5,910.00
	Sum		$116,230.00
	Price per Watt		$7.86

B.6 SOLAR SYSTEM PERFORMANCE.

To simulate the solar system performance we have used the HOMER, a software designed for power system generation simulations.

We have considered as the best architecture the system described in Exhibit B.5 above. The solar system would contribute 46.4% of the total generation. The grid will participate with the difference as shown in Exhibit B.6. The total energy generated by both is 53,230 kWh/year. The PV array will produce 24,679 kWh./year and the cost of the energy generated would be 0.430 USD/kWh.

We have considered a small battery bank since the main goal will be to provide backup energy for a maximum of 3 hours of autonomy. Based on the probability of black outs. The battery bank will remain under excellent charge conditions, and the expected life time is 8 years as minimum.

Exhibit B.6 shows the simulation of the load versus the solar system contribution and the energy from the grid; note the weekend low demand and high solar energy production.

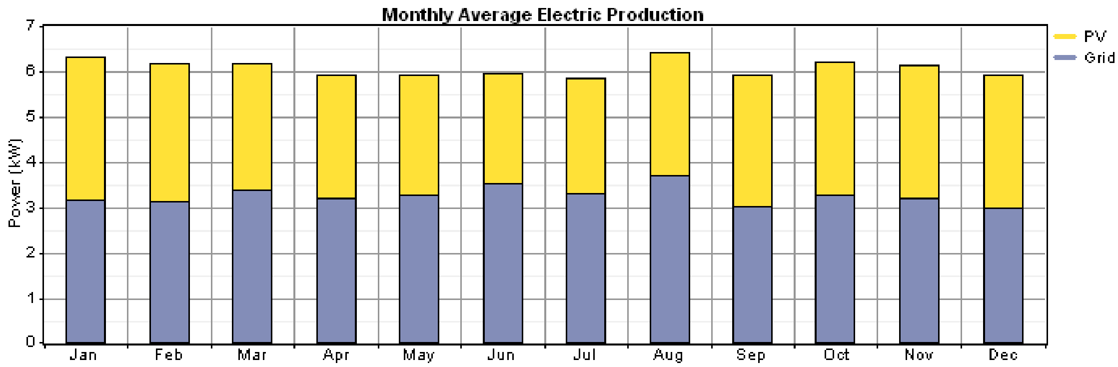

Exhibit B.6 M monthly average electric production.

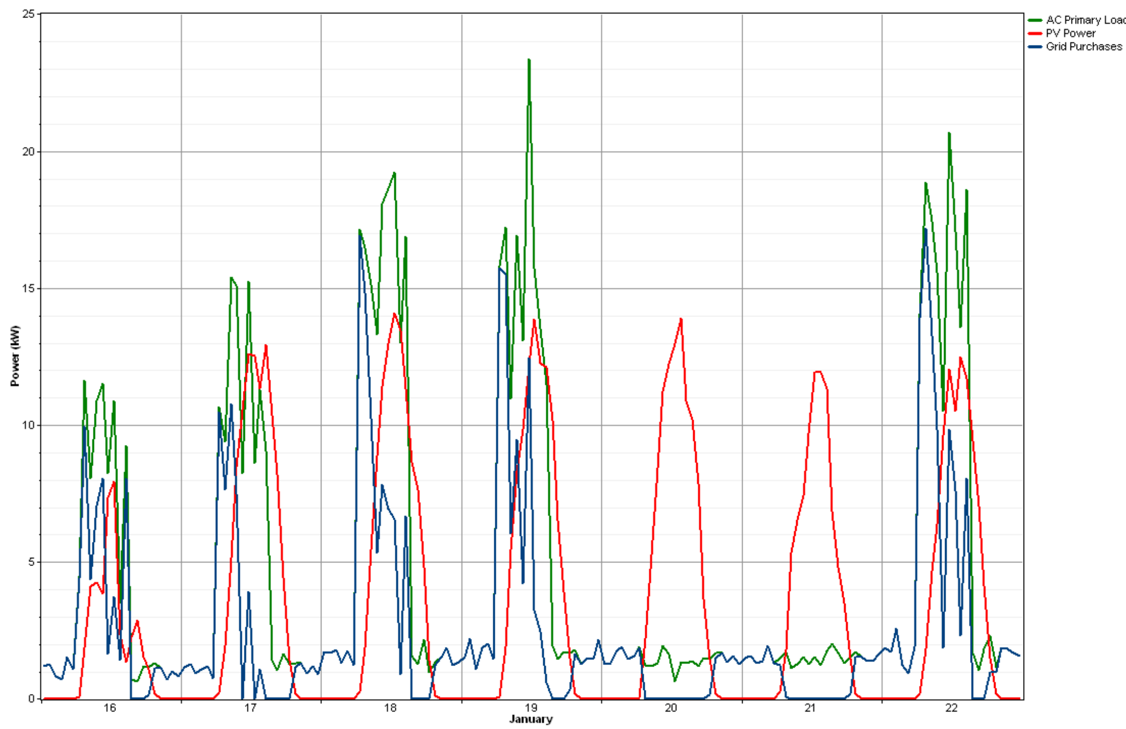

Exhibit B.7 Loads versus the solar energy production and the energy from the grid.

B.7 CONCLUSIONS

The solar system could contribute to increasing the quality of the energy supplied at Xai Xai, providing clean and green energy to the hospital even though the cost of the energy will be higher than they are buying now.

15 kW of solar system seems to be high for only the laboratory however the system also could help to ensure the high quality of energy required for equipment and lab instruments. A grid tied solar systems could be another alternative when/if it is valid in Mozambique to sell energy to the utility.

APPENDIX C: SAMPLE SPECIFICATION SHEET FOR A UPS

SPECIFICATIONS FOR UPS					
Nominal power (KVA)	2	5	10	15	20
Operating principle	On-line double conversion technique				
INPUT	3-phase				
Voltage	208 or 240 Vac				
Bypass Voltage window	184 -260 or 195-260 Vac (programable)				
Frequency	50/ 60 Hz +/- 5% Synchornized Auto Tracking)				
Power factor correction	Up to 90%				
Efficiency (AC-AC)	Up to 90%				
Battery mode	0.85				
OUTPUT					
Watts					
Voltage	240 volts - 3 wire + ground				
Overload capability	105% of 3500 Watts continuos output				
Voltage Regulations	+/- 2%				
Voltage Adjustment	+/- 0%, +/- 1%, +/- 2%, +/- 3% (Programable)				
Frequency	50/ 60 Hz +/- 5% Synchornized Auto Tracking)				
Frequency Stability (network sync)	+/- 0.2%,Fixed frequency operation				
Frequency window	+/- 0.2%				
Harmonic Distortion	5% typical				
Crest Ratio	3:1				
BATTERY					
DC Volts	240 Vdc				
Type	12 V, 7AH sealed battery lead acid maintenance free				
Charger Current	1.5 A				
Back up Time Full load	45 minutes				
Recharge time	12 hours to 90%				
TRANSFER TIME					
Line fails /recover	0 sec				
UPS to by pass or reverse	0-1 ms				
After overload	Auto transfer to UPS				
ELECTRICAL CONNECTIONS					
INPUT	Hardwire terminal block				
OUTPUT	Hardwire terminal block				
Repo	hardwire connection supplied				
ENVIRONMENTAL					
Operating temperature	0° to -40° C				
Humidity	10% to 95% no condensing				
Altitud	3000 m				
Cooling	low velocity forced air fans				
Audible noice @ 1m	50 dbA				
CONTROL AND INDICATORS					
Status on LCD &LED	Line mode, Back up mode, ECO mode, Bypass, Low battery, defective battery, Overload, UPS Alarm, Transfering with interuption				
LCD displayed readings	Input Voltage, Input frequency, Output Voltage, Output Frequency,Load percentage, Battery voltage, Internat Temperature				
Self diagnostics	At power up, Manual front panel button, software control with programabel 24 hours authomatic self test.				
Audible Alarm	Utillity loss, Low battery, transfer to by pass and UPS failure.				
Communications	RS 232 Port				

APPENDIX D: **DETAILED ENERGY ASSESSMENT SHEETS**

D.1 CENTRAL HOSPITAL MICROBIOLOGY

D.1.1 General

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name CENTRAL HOSPITAL – MICROBIOLOGY

General Site Information

Item	Input	Remarks
Date of Audit	27 August 2010	02:44 p.m.
Name of Auditor	Arturo Romero P & Mark Oven	
Affiliation of Auditor	ENT - TT	
Site Coordinates	19° 23' 50" S, 99°9' 39" W	
Estimated driving time from Maputo	20 min	reference point Hotel Avenida
Road condition	excellent	
Contact Person at Site:		ENG. MABOTS
Phone Number of Contact Persons at Site:		**84322242004**
Title of Contact Person	Responsible of the lab	
Department	Laboratory	
Type of Facility	Laboratory	CENTRAL HOSPITAL
Number of Patients per day		
Describe Facility	CENTRAL HOSPITAL	e.g. Lab, computer center, etc…

2. System Sizing and Costs

Item	Input	Remarks
For Labs: Is this a Basic, Palliative Care, or ARV lab?		
Does this facility have a server?	yes	
Operating Hours of Facility:	0700 to 1530	
Operating Days of Facility:	From Monday to Friday even some weekends too	
Are there air conditioners in use in this facility, or planned to be in use?	yes one per room as minimum	
Provide roof plan and photo		

D.1.2 Site power

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name	CENTRAL HOSPITAL - MICROBIOLOGY

Site Power Supplies

Item	Input	Remarks
Grid		
Is the site connected to grid?	YES it is connected to the grid	
If YES, describe when grid is usually ON between the hours of 0700 and 1900 hrs.	24 hours	
If Yes, describe when EDM is usually ON between the hours of 1900 and 0700 hours.	24 hours	
Add any comments regarding the power availability of GRID, power quality of GRID, or any other observations.	Lab's responsible said the facility has a UPS to reduce the voltaje variations and black outs	
DELCO / GENERATOR		
Is the generator for the entire facility, or dedicated to these loads?	YES a big one for the Hospital	
Distance between generator and load center		
From Generator Nameplate:		
Manufacturer and Model No.		
Provide Data for Continuous Power Ratings:		
KVA		
KW		
Power Factor		
Voltage and Phase		

2. System Sizing and Costs

Item	Input	Remarks
Overall Condition and age of Generator		
Is it connected 1-Phase or 3-Phase		
How many hours/day does it run?		
How much fuel per hour or per day does it consume?		
Diameter of wires (feeder) to LC		
Overall wiring of the facility		
Is there a Grounding system?		
Provide Photos of Generator		

NOTES:

D.1.3 Cont & nc loads

Facility Name CENTRAL HOSPITAL - MICROBIOLOGY

Existing Loads

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
ROOM #1	1	Incubator Sine 2000 Scientific mod 291	800	5	10			4,000	8,000	-	-	12,000	-	800	-
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
	1	Harner 15/80Centrifuge	1000	4				4,000	-	-	-	4,000	-	1,000	-
	1	Magnetic Stirrer	74.8	3				224	-	-	-	224	-	75	-
	1	Magnetic Stirrer	74.8	3				224	-	-	-	224	-	75	-
	1	Microscope	25			5		-	-	125	-	-	125	-	25
CORRIDOR	2	Refrigerator west point	250	4	9			2,000	4,500	-	-	6,500	-	500	-
	1	Refrigerator + UPS	250	4	9			1,000	2,250	-	-	3,250	-	250	-
	2	Refrigerator west Power	250	4	9			2,000	4,500	-	-	6,500	-	500	-
	1	Refrigerator doble coolmaster	350	4	9			1,400	3,150	-	-	4,550	-	350	-

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
	1	Refrigerator horizontal	200	4	9			800	1,800	-	-	2,600	-	200	-
ROOM #2	1	Vitek 32	550	5				2,750	-	-	-	2,750	-	550	-
	3	Computer	250			8		-	-	6,000	-	-	6,000	-	750
	1	Harner 15/80Centrifuge	1000	4				4,000	-	-	-	4,000	-	1,000	-
	1	Memmert water bath	1000	5	10			5,000	10,000	-	-	15,000	-	1,000	-
	1	microscope	25			5		-	-	125	-	-	125	-	25
ROOM #3	1	microscope	25			5		-	-	125	-	-	125	-	25
	1	computer	250			8		-	-	2,000	-	-	2,000	-	250
	1	Cabine thermo scyentific	750	8				6,000	-	-	-	6,000	-	750	-
	1	microscope	25			5		-	-	125	-	-	125	-	25
	1	Johuan oven	1200	6				7,200	-	-	-	7,200	-	1,200	-
ROOM #4	1	computer	250			8		-	-	2,000	-	-	2,000	-	250
	1	lavatech	125	6				750	-	-	-	750	-	125	-
	1	Johuan oven	1200	6				7,200	-	-	-	7,200	-	1,200	-
	1	Microscope	25			5		-	-	125	-	-	125	-	25
ROOM#5	1	Harner 15/80Centrifuge	1000	4				4,000	-	-	-	4,000	-	1,000	-
	3	Microscopes Olympus	55			5		-	-	825	-	-	825	-	165

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
	1	Printer	55	3				165	-	-	-	165	-	55	-
	1	computer	250			8		-	-	2,000	-	-	2,000	-	250
ROOM#6	1	Lab Tech oven	2000	6				12,000	-	-	-	12,000	-	2,000	-
	1	Melac oven	2000	6				12,000	-	-	-	12,000	-	2,000	-
	1	Kotteman	440	6				2,640	-	-	-	2,640	-	440	-
	1	Autoclave	3520	4				14,080	-	-	-	14,080	-	3,520	-
								-	-	-	-	-	-	-	-
Grand Totals								**93,434**	**34,200**	**15,450**	**-**	**127,634**	**15,450**	**18,590**	**2,040**

D.1.4 Charging sc

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name CENTRAL HOSPITAL - MICROBIOLOGY

Charging Scenarios

Carry Forward Load Information From Previoius Sheets	Contact Loads – Distributed Watthours Time A	Contact Loads – Distributed Watthours Time B	Contact Loads – Distributed Watthours Time C	Contact Loads – Total WHRS	Contact Loads – Total Conn Watts	No-Contact Loads – Distributed Watthours Time A	No-Contact Loads – Distributed Watthours Time B	No-Contact Loads – Distributed Watthours Time C	No-Contact Loads – Total WHRS	No-Contact Loads – Total Conn Watts	Grand Totals – Total WHRS	Grand Totals – Total Conn Watts
Totals for Existing Loads, Page 1	93,434	17,100	17,100	127,634	18,590	15,450	-	-	15,450	2,040	143,084	20,630
Totals for Future Loads, Page 2												
Total Load Distribution	**93,434**	**17,100**	**17,100**	**127,634**	**18,590**	**15,450**	**-**	**-**	**15,450**	**2,040**	**143,084**	**20,630**
Charger Operating Times (Hours for **A Contact** automatically equal hours for **A No contact**, etc.)	8	8	8			8	8	8				

Reconfigure Loads based on when the Charger is Operating	Contact Loads Distributed Watthours Time A	Contact Loads Distributed Watthours Time B	Contact Loads Distributed Watthours Time C	No-Contact Loads Distributed Watthours Time A	No-Contact Loads Distributed Watthours Time B	No-Contact Loads Distributed Watthours Time C

Loads While Charger is Operating	93,434	17,100	17,100			15,450	-	-				
Loads While Charger is NOT Operating	-	-	-			-	-	-				
	Contact Loads					No-Contact Loads					Grand Totals	
		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Totals to be used in Battery and Charger Sizing Design		127,634	-	127,634	18,590		15,450	-	15,450	2,040	143,084	20,630
Error Check (Green = OK)				-	-				-	-	-	-

D.1.5 Efficiencies

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name	CENTRAL HOSPITAL - MICROBIOLOGY

System Efficiencies and Inputs

User Entries only in Column D

Description	Eff ή %	Discussion	Default Value %					
Values Used in Battery and Charger Sizing								
Battery	80%	Eff for change from Chemical to Electrical energy. 80% to 85% for Lead Acid	80%	a				
Inverter	90%	Inverter Efficiencies peak higher but generally at full to maximum loads.	90%	b				
Charger - in Inverter / Charger	80%	The charger section is generally less efficient than the inverter section.	80%	c				
AC Wiring	97%	Assuming efficient wiring design	97%	d				
Depth of Discharge	50%		50%	e				
Days of Autonomy	1		1	f				
Values Used in PV Array Sizing								
Charge Controller	96%	Assume MPPT Charge Controller	95%	g				

DC Wiring	97%	Assume efficient wiring design	97%	h				
Panel Mult. Factors	92%	Includes adjustments for nameplate ratings, panel mismatch, dust.	88%	i				
Temperature Factor	85%	Ambient of 30 deg = 15%: 35 deg = 83.5%	84%	j				
System Voltage (DC)	48		48					
PSH for Design	5.5	Mozambique PSH = 5.0 to 5.5	6					
System Voltage (AC - 2Ph)	220	Mozambique = 220V; ROW - 230VAC	120					
Resulting System Efficiencies **Battery Sizing Inputs**			**Contact Loads**	**No Contact Loads**				
While Charging is in Operation								
		No load on the battery for Contact Loads	N/A					
		Charger, Inverter, AC Wiring (b,c,d,)		70%				
While Charging is NOT in Operation								
		Battery, Inverter AC Wiring (a,b,d)	70%	70%				

D.1.6 Batty-chrgr sizing

Site Energy Assessments
MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name CENTRAL HOSPITAL - MICROBIOLOGY

No luser Inputs on this Sheet

Battery & Charger Sizing

Values Carried over from Charging Scenarios			Contact Loads: Distributed Watthours Charging On	Contact Loads: Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts		No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Required AC Values at Load	AC	-	127,634	-	127,634	18,590	-	15,450	-	15,450	2,040	143,084	20,630
Adjust for Inverter and Battery	DC			-					-				
Adjust for Inverter and Charger	DC							22,122					
No Adjustment Needed	AC		127,634										
Battery Sizing			**0.00%**										
Total WHR Loads during no charging source	DC		-										
System DC Voltage	48												

Values Carried over from Charging Scenarios		Contact Loads: Distributed Watthours Charging On	Contact Loads: Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts	No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Total AHR Required in Battery for the loaads during no charging source.		-									
Design Depth of Discharge	50%										
Required AHR required for one Day of Loads		-									
Days of Autonomy	1										
Required Battery Bank Size	AH	-									
Charger Sizing											
Total WHR required by No Contact Loads during Charging	DC	22,122									
System DC Voltage	48										
Required Additional AHR in Charger for No Contact Loads		461									
Required AHRS for Battery as Calculated above in Battery Sizing		-									
Adjust for Charger Inefficiency	80%	-									
Total AHR Requirement from Chargers	AHR	461									
Plus Safety Margin	1.25	576									
Hours of Charging	H	24									
Required Charger Amps	AMPS	24									

D.2 CENTRAL HOSPITAL BIOCHEMISTRY

D.2.1 General

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name CENTRAL HOSPITAL - BIOCHEMISTRY

General Site Information

Item	Input	Remarks
Date of Audit	25 August 2010	10:00 HEMATOLOGY AND BIOCHEMISTRY
Name of Auditor	Arturo Romero P & Mark Oven	
Affiliation of Auditor	ENT - TT	
Site Coordinates	19° 23' 50" S, 99°9' 39" W	
Estimated driving time from Maputo	20 min	reference point Hotel Avenida
Road condition	excellent	
Contact Person at Site:	Ivonne Gomez	Eugenio Fernando
Phone Number of Contact Persons at Site:		
Title of Contact Person	Responsible of the lab	
Department	Laboratory	
Type of Facility	Laboratory	CENTRAL HOSPITAL
Number of Patients per day		
Describe Facility	CENTRAL HOSPITAL	e.g. Lab, computer center, etc...
For Labs: Is this a Basic, Palliative Care, or ARV lab?		

Item	Input	Remarks
Does this facility have a server?	yes	
Operating Hours of Facility:	0700 to 1530	
Operating Days of Facility:	From Monday to Friday even some weekends too	
Are there air conditioners in use in this facility, or planned to be in use?	yes one per room as minimum	
Provide roof plan and photo		

D.2.2 Site power

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name CENTRAL HOSPITAL - BIOCHEMISTRY

Site Power Supplies

Item	Input	Remarks
Grid		
Is the site connected to grid?	YES it is connected to the grid	
If YES, describe when grid is usually ON between the hours of 0700 and 1900 hrs.	24 hours	
If Yes, describe when EDM is usually ON between the hours of 1900 and 0700 hours.	24 hours	
Add any comments regarding the power availability of GRID, power quality of GRID, or any other observations.	Lab's responsible said the facility has a UPS to reduce the voltaje variations and black outs	
DELCO / GENERATOR		
Is the generator for the entire facility, or dedicated to these loads?	YES a big one for the Hospital	
Distance between generator and load center		
From Generator Nameplate:		
Manufacturer and Model No.		
Provide Data for Continuous Power Ratings:		
KVA		
KW		
Power Factor		
Voltage and Phase		

Item	Input	Remarks
Overall Condition and age of Generator		
Is it connected 1-Phase or 3-Phase		
How many hours/day does it run?		
How much fuel per hour or per day does it consume?		
Diameter of wires (feeder) to LC		
Overall wiring of the facility		
Is there a Grounding system?		
Provide Photos of Generator		

NOTES:

D.2.3 Cont & nc loads

Facility Name **CENTRAL HOSPITAL - BIOCHEMISTRY**

Existing Loads

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	**QTY**	**Load**	**Watts Each**	**Hrs per Day Day**	**Hrs per Day Night**	**Hrs per Day Day**	**Hrs per Day Night**	**Watthours Day**	**Watthours Night**	**Watthours Day**	**Watthours Night**	**Contact Watthrs Total**	**No-Contact Watthrs Total**	**Cont Total Conn Watts**	**NC Total Conn Watts**
Oficina	1	Refrigerator	250	4	9			1,000	2,250	-	-	3,250	-	250	-
	1	Printer laser HP	450	3				1,350	-	-	-	1,350	-	450	-
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
Area #1	2	Refrigerator	250	4	9			2,000	4,500	-	-	6,500	-	500	-
	1	Cobas Integra 400 + UPS	1200			7		-	-	8,400	-	-	8,400	-	1,200
	1	Densitometro Beckman	250			6		-	-	1,500	-	-	1,500	-	250
	2	Computer DELL + UPS	250			8		-	-	4,000	-	-	4,000	-	500
	1	Bechman Coulter Acces 2	1320			6		-	-	7,920	-	-	7,920	-	1,320
	1	Oven	2300	5	10			11,500	23,000	-	-	34,500	-	2,300	-
Area #2	1	Olympus AU640	4000			6		-	-	24,000	-	-	24,000	-	4,000
	1	Printer w/ Olympus	125	3				375	-	-	-	375	-	125	-

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
	2	Computer DELL + UPS	250			8		-	-	4,000	-	-	4,000	-	500
	2	Refrigerator 815L	350	4	9			2,800	6,300	-	-	9,100	-	700	-
	2	Bechman Coulter Erics XL MCL	2200			6		-	-	26,400	-	-	26,400	-	4,400
	1	Synchron XC9 Clinical system ALX	1700			5		-	-	8,500	-	-	8,500	-	1,700
	1	Water distiller	1000	5				5,000	-	-	-	5,000	-	1,000	-
	1	Printer to Olympus	55	3				165	-	-	-	165	-	55	-
	1	Printer OKI	250	3				750	-	-	-	750	-	250	-
	1	Refrigerator horizonal small	125	4	9			500	1,125	-	-	1,625	-	125	-
	1	Centrifuge Beckman C5-6	180	5				900	-	-	-	900	-	180	-
Area #3	1	Refrigerator 351 L Farmacy double	350	4	9			1,400	3,150	-	-	4,550	-	350	-
	3	Computer	250			8		-	-	6,000	-	-	6,000	-	750
	3	Printer OKI Microline 3320	250	3				2,250	-	-	-	2,250	-	750	-
	2	Sysmex Modelo XE 2100	184			4		-	-	1,472	-	-	1,472	-	368
Area #4	2	Computer	250			8		-	-	4,000	-	-	4,000	-	500
	1	Printer HP laser	450	3				1,350	-	-	-	1,350	-	450	-
TB Laboratory	1	Bactec MGIT 960	1100			7		-	-	7,700	-	-	7,700	-	1,100

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
	1	Centrifuge HARRIER 15/80	180	5				900	-	-	-	900	-	180	-
	1	Incubator memmert B	3300	5	10			16,500	33,000	-	-	49,500	-	3,300	-
	1	incubator Memmert S	800	5	10			4,000	8,000	-	-	12,000	-	800	-
	2	Cabine Cabine Bio2 Cab	750	8				12,000	-	-	-	12,000	-	1,500	-
	1	Refrigerator West Point	250	4	9			1,000	2,250	-	-	3,250	-	250	-
	1	Freezer	350	4	9			1,400	3,150	-	-	4,550	-	350	-
	2	microscope	25			5		-	-	250	-	-	250	-	50
	1	Refrigerator DEFI	250	4	9			1,000	2,250	-	-	3,250	-	250	-
	1	Shaker Rotary	30	4				120	-	-	-	120	-	30	-
	1	Shaker VAN200	30	4				120	-	-	-	120	-	30	-
	1	Incubator Scientific	4840	5	10			24,200	48,400	-	-	72,600	-	4,840	-
	1	Oven Cabtech Universal Drying	2000	5	10			10,000	20,000	-	-	30,000	-	2,000	-
	2	Incubator Jouan	1200	5	10			12,000	24,000	-	-	36,000	-	2,400	-
	2	microscopes	25			5		-	-	250	-	-	250	-	50
	2	Computer DELL + UPS	250			8		-	-	4,000	-	-	4,000	-	500
	2	Refrigerator Farmacia double	350	4	9			2,800	6,300	-	-	9,100	-	700	-

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
	1	Cabine	750	8				6,000	-	-	-	6,000	-	750	-
	1	Incubator VITEK 32 biomerieux	2200	5	10			11,000	22,000	-	-	33,000	-	2,200	-
								-	-	-	-	-	-	-	-
								-	-	-	-	-	-	-	-
Grand Totals								**134,380**	**209,675**	**110,392**	**-**	**344,055**	**110,392**	**27,065**	**17,438**

Total contact & no-contact WHrs	454,447
Total contact & no-contact Ahrs	9,467.65
Number of Strings of 8 rolls 6V 350AH Batty	27.05

D.2.4 Charging sc

Site Energy Assessments
MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name CENTRAL HOSPITAL - BIOCHEMISTRY

Charging Scenarios

Carry Forward Load Information From Previoius Sheets	Contact Loads					No-Contact Loads					Grand Totals	
	Distributed Watthours			Total	Total	Distributed Watthours			Total	Total	Total	Total
	Time A	Time B	Time C	WHRS	Conn Watts	Time A	Time B	Time C	WHRS	Conn Watts	WHRS	Conn Watts
Totals for Existing Loads, Page 1	134,380	104,838	104,838	344,055	27,065	110,392	-	-	110,392	17,438	454,447	44,503
Totals for Future Loads, Page 2												
Total Load Distribution	**134,380**	**104,838**	**104,838**	**344,055**	**27,065**	**110,392**	**-**	**-**	**110,392**	**17,438**	**454,447**	**44,503**
Charger Operating Times (Hours for **A Contact** automatically equal hours for **A No contact**, etc.)	8	8	8			8	8	8				
Reconfigure Loads based on	**Contact Loads Distributed Watthours**					**No-Contact Loads Distributed Watthours**						

when the Charger is Operating	Time A	Time B	Time C		Time A	Time B	Time C	
Loads While Charger is Operating	134,380	104,838	104,838		110,392	-	-	
Loads While Charger is NOT Operating	-	-	-		-	-	-	

	Contact Loads					No-Contact Loads					Grand Totals	
		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Totals to be used in Battery and Charger Sizing Design		344,055	-	344,055	27,065		110,392	-	110,392	17,438	454,447	44,503
Error Check (Green = OK)				-	-				-	-	-	-

D.2.5 Efficiencies

Site Energy Assessments
MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name CENTRAL HOSPITAL - BIOCHEMISTRY

System Efficiencies and Inputs

User Entries only in Column D

Description	Eff ή %	Discussion	Default Value %					
Values Used in Battery and Charger Sizing								
Battery	80%	Eff for change from Chemical to Electrical energy. 80% to 85% for Lead Acid	80%	a				
Inverter	90%	Inverter Efficiencies peak higher but generally at full to maximum loads.	90%	b				
Charger - in Inverter / Charger	80%	The charger section is generally less efficient than the inverter section.	80%	c				
AC Wiring	97%	Assuming efficient wiring design	97%	d				
Depth of Discharge	50%		50%	e				

Description	Eff ή %	Discussion	Default Value %					
Days of Autonomy	1		1	f				
Values Used in PV Array Sizing								
Charge Controller	96%	Assume MPPT Charge Controller	95%	g				
DC Wiring	97%	Assume efficient wiring design	97%	h				
Panel Mult. Factors	92%	Includes adjustments for nameplate ratings, panel mismatch, dust.	88%	i				
Temperature Factor	85%	Ambient of 30 deg = 15%: 35 deg = 83.5%	84%	j				
System Voltage (DC)	48		48					
PSH for Design	5.5	Mozambique PSH = 5.0 to 5.5	6					
System Voltage (AC - 2Ph)	220	Mozambique = 220V; ROW - 230VAC	120					
Resulting System Efficiencies **Battery Sizing Inputs**			**Contact Loads**	**No Contact Loads**				
While Charging is in Operation								
		No load on the battery for Contact Loads	N/A					
		Charger, Inverter, AC Wiring (b,c,d,)		70%				
While Charging is NOT in Operation								
		Battery, Inverter AC Wiring (a,b,d)	70%	70%				

D.2.6 Batty-chrgr sizing

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name CENTRAL HOSPITAL - BIOCHEMISTRY

No luser Inputs on this Sheet

Battery & Charger Sizing

Values Carried over from Charging Scenarios			Contact Loads: Distributed Watthours Charging On	Contact Loads: Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts		No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Required AC Values at Load	AC	-	344,055	-	344,055	27,065	-	110,392	-	110,392	17,438	454,447	44,503
Adjust for Inverter and Battery	DC			-					-				
Adjust for Inverter and Charger	DC							158,064					
No Adjustment Needed	AC		344,055										
Battery Sizing			**0.00%**										
Total WHR Loads during no charging source	DC		-										
System DC Voltage	48												

Values Carried over from Charging Scenarios		Contact Loads				No-Contact Loads				Grand Totals	
		Distributed Watthours		Total	Total	Distributed Watthours		Total	Total	Total	Total
		Charging On	Charging Off	WHRS	Conn Watts	Charging On	Charging Off	WHRS	Conn Watts	WHRS	Conn Watts
Total AHR Required in Battery for the loaads during no charging source.		-									
Design Depth of Discharge	50%										
Required AHR required for one Day of Loads		-									
Days of Autonomy	1										
Required Battery Bank Size	AH	-									
Charger Sizing											
Total WHR required by No Contact Loads during Charging	DC	158,064									
System DC Voltage	48										
Required Additional AHR in Charger for No Contact Loads		3,293									
Required AHRS for Battery as Calculated above in Battery Sizing		-									
Adjust for Charger Inefficiency	80%	-									
Total AHR Requirement from Chargers	AHR	3,293									
Plus Safety Margin	1.25	4,116									
Hours of Charging	H	24									
Required Charger Amps	AMPS	172									

D.3 INS INMUNOLOGY & VIR. REF. LAB

D.3.1 General

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name INS IMMUNOLOGY AND VIROLOGY REFERENCE LAB

General Site Information

Item	Input	Remarks
Date of Audit	26 August 2010	9:00 Molecular Biology
Name of Auditor	Arturo Romero P & Mark Oven	
Affiliation of Auditor	ENT -- TT	
Site Coordinates		
Estimated driving time from Maputo	20 min	reference point Hotel Avenida
Road condition	excellent	
Contact Person at Site:	Angelo Augusto	
Phone Number of Contact Persons at Site:	823103890	angelomzh@yahoo.com.br
Title of Contact Person	Responsible in the Lab.	
Department	Laboratory	
Type of Facility	Reference Laboratory	Health Center, Hospital, etc.
Number of Patients per day		
Describe Facility	Instituo Nacionale de Salude	e.g. Lab, computer center, etc...
For Labs: Is this a Basic, Palliative Care, or ARV lab?		
Does this facility have a	yes	

Item	Input	Remarks
server?		
Operating Hours of Facility:	0700 to 1530	
Operating Days of Facility:	From Monday to Friday even some weekends too	
Are there air conditioners in use in this facility, or planned to be in use?		
Provide roof plan and photo		

D.3.2 Site power

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name INS IMMUNOLOGY AND VIROLOGY REFERENCE LAB

Site Power Supplies

Item	Input	Remarks
Grid		
Is the site connected to grid?	YES it is connected to the grid	
If YES, describe when grid is usually ON between the hours of 0700 and 1900 hrs.	24 hours	
If Yes, describe when EDM is usually ON between the hours of 1900 and 0700 hours.	24 hours	
Add any comments regarding the power availability of GRID, power quality of GRID, or any other observations.	Lab's responsible said the facility has a UPS to reduce the voltaje variations and black outs	
DELCO / GENERATOR		
Is the generator for the entire facility, or dedicated to these loads?	YES	They have a big UPS
Distance between generator and load center		since 2008 has ran 316 hours - 0.5 h/day Avg.
From Generator Nameplate:	GESAN- Perkins	
Manufacturer and Model No.		
Provide Data for Continuous Power Ratings:		
KVA		
KW	20	
Power Factor		
Voltage and Phase		

Item	Input	Remarks
Overall Condition and age of Generator	2 years excellent conditions	
Is it connected 1-Phase or 3-Phase	3 Phases	
How many hours/day does it run?	0.5 Hours/day average in two years	They do not use it
How much fuel per hour or per day does it consume?		
Diameter of wires (feeder) to LC		
Overall wiring of the facility		
Is there a Grounding system?		
Provide Photos of Generator		

NOTES:

D.3.3 Cont & nc loads

INS IMMUNOLOGY AND VIROLOGY REFERENCE LAB

			Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
1	centrifuge Heraeus	180	5				900	-	-	-	900	-	180	-
2	Cabine Hera safe	750	8				12,000	-	-	-	12,000	-	1,500	-
2	BD FACS Calibur + computer+printer + UPS	1725			6		-	-	20,700	-	-	20,700	-	3,450
2	Computer HP + UPS	250			8		-	-	4,000	-	-	4,000	-	500
1	Refrigerator West point	250	4	9			1,000	2,250	-	-	3,250	-	250	-
1	Freezer Blue (-80°C) Fiochetti D216	350	4	9			1,400	3,150	-	-	4,550	-	350	-
2	Printer HP	75	3				450	-	-	-	450	-	150	-
0	Air conditioner	1000					-	-	-	-	-	-	-	-
1	Sysmex KX 21N	184			4		-	-	736	-	-	736	-	184
1	selectra junior c/comerat + impresora + computer				6		-	-	-	-	-	-	-	-
1	BD FACS Count	1320			6		-	-	7,920	-	-	7,920	-	1,320
1	Incubator thermo Heraeus	2200	5	10			11,000	22,000	-	-	33,000	-	2,200	-

			Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
1	Cabine LAB 2 AIR	750	8				6,000	-	-	-	6,000	-	750	-
6	Refrigerator	250	4	9			6,000	13,500	-	-	19,500	-	1,500	-
2	micro plaque lav	220	3				1,320	-	-	-	1,320	-	440	-
1	Stirrer	30	4				120	-	-	-	120	-	30	-
1	incubator - shaker IEMS D223	800	5	10			4,000	8,000	-	-	12,000	-	800	-
1	Centrifuges Retrofix 32 HETTICH	286	5				1,430	-	-	-	1,430	-	286	-
1	Centrifugue HETTICH	143	5				715	-	-	-	715	-	143	-
2	Computer HP	250			8		-	-	4,000	-	-	4,000	-	500
1	Printer epson 1x300	45	3				135	-	-	-	135	-	45	-
1	multiscan Ascent	120			4		-	-	480	-	-	480	-	120
1	Cabine Airvolution	750	8				6,000	-	-	-	6,000	-	750	-
1	Refrigerator (F10)	250	4	9			1,000	2,250	-	-	3,250	-	250	-
1	Cobas Integra 400 + UPS	1200			7		-	-	8,400	-	-	8,400	-	1,200
3	Computer DELL + UPS	250			8		-	-	6,000	-	-	6,000	-	750
1	Cobas Taqman 48	1200			7		-	-	8,400	-	-	8,400	-	1,200
1	Photo Camera Bio Rad	45			4		-	-	180	-	-	180	-	45
1	Multiscan Ascent	120			4		-	-	480	-	-	480	-	120

			Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
1	Bio TFK plate	1386			7		-	-	9,702	-	-	9,702	-	1,386
1	Cabine LAB 2 AIR	750	8				6,000	-	-	-	6,000	-	750	-
1	Chromo and data DNA engine	850			6		-	-	5,100	-	-	5,100	-	850
1	UV light	15	6				90	-	-	-	90	-	15	-
1	Electrophoresis Bio Rad	500	6				3,000	-	-	-	3,000	-	500	-
1	Microwave Oven	1300	3				3,900	-	-	-	3,900	-	1,300	-
1	Gel Toaster (dryer)	150	5				750	-	-	-	750	-	150	-
1	PCR Custom 2700	200	4				800	-	-	-	800	-	200	-
1	Thermo cicling + UV	500	5				2,500	-	-	-	2,500	-	500	-
1	memo electron megafuge	1276			3		-	-	3,828	-	-	3,828	-	1,276
1	Cabine LAB 2 AIR	750	8				6,000	-	-	-	6,000	-	750	-
1	computer HP	250			8		-	-	2,000	-	-	2,000	-	250
1	Corbett Robotex	250			6		-	-	1,500	-	-	1,500	-	250
1	Thermomixer compact agitador	500	5				2,500	-	-	-	2,500	-	500	-
1	Rotonia 460	220			4		-	-	880	-	-	880	-	220
1	Centrifuge plaque	1430	5				7,150	-	-	-	7,150	-	1,430	-
1	Freezer DAIREI -7.5 ℃	450	4	9			1,800	4,050	-	-	5,850	-	450	-

			Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
1	Incubator + UV	1250	5	10			6,250	12,500	-	-	18,750	-	1,250	-
1	Freezer Fiochetti (-20℃)	450	4	9			1,800	4,050	-	-	5,850	-	450	-
1	Refrigerator Dairei 5℃	220	4	9			880	1,980	-	-	2,860	-	220	-
1	Cabine LAB 2 AIR	750	8				6,000	-	-	-	6,000	-	750	-
3	Stirrer	30	4				360	-	-	-	360	-	90	-
2	Computer (HP & MAC)	250			8		-	-	4,000	-	-	4,000	-	500
2	Printer HP	75	3				450	-	-	-	450	-	150	-
1	Refrigerator West point	250	4	9			1,000	2,250	-	-	3,250	-	250	-
1	Cabine ICN flow BSB 36	2640	8				21,120	-	-	-	21,120	-	2,640	-
1	Blood Punch DBS	220	4				880	-	-	-	880	-	220	-
1	Shel lab 180℃ High heat decontamination CO2	350	6				2,100	-	-	-	2,100	-	350	-
1	cabinet Nuaire labgard	500	8				4,000	-	-	-	4,000	-	500	-
1	Freezer F20	350	4	9			1,400	3,150	-	-	4,550	-	350	-
1	Centrifuge Bechman Coulter X12R	180	5				900	-	-	-	900	-	180	-
1	Freezer Bosch	350	4	9			1,400	3,150	-	-	4,550	-	350	-
1	Freezer Gallen sharp	450	4	9			1,800	4,050	-	-	5,850	-	450	-
1	Freezer c12	350	4	9			1,400	3,150	-	-	4,550	-	350	-

			Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
			Hrs per Day		Hrs per Day						Contact	No-Contact	Cont	NC
QTY	Load	Watts Each	Day	Night	Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Watthrs Total	Watthrs Total	Total Conn Watts	Total Conn Watts
2	Freezer	350	4	9			2,800	6,300	-	-	9,100	-	700	-
1	centrifuge 5415 D Eppendorf	180	5				900	-	-	-	900	-	180	-
1	Chemometec nucler counter	25			6		-	-	150	-	-	150	-	25
1	CTL inmuno sopt	660			6		-	-	3,960	-	-	3,960	-	660
3	Microscopes	25			5		-	-	375	-	-	375	-	75
1	saker	11	4				44	-	-	-	44	-	11	-
1	saker magnetic	660	4				2,640	-	-	-	2,640	-	660	-
3	Freezer	350	4	9			4,200	9,450	-	-	13,650	-	1,050	-
1	Cabine LAB 2 AIR	750	8				6,000	-	-	-	6,000	-	750	-
1	Refrigerator Farmacia	220	4	9			880	1,980	-	-	2,860	-	220	-
1	Refrigerator Electrolux TFW 791	250	4	9			1,000	2,250	-	-	3,250	-	250	-
1	Freezer Fioccetti	450	4	9			1,800	4,050	-	-	5,850	-	450	-
							-	-	-	-	-	-	-	-
							159,964	**113,510**	**92,791**	**-**	**273,474**	**92,791**	**28,990**	**14,881**

			Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
			Hrs per Day		Hrs per Day									
QTY	Load	Watts Each	Day	Night	Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts

Total contact & no-contact WHrs	366,265
Total contact & no-contact Ahrs	7,630.52
Number of Strings of 8 rolls 6V 350AH Batty	21.80

D.3.4 Charging sc

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name: INS IMMUNOLOGY AND VIROLOGY REFERENCE LAB

Charging Scenarios

Carry Forward Load Information From Previoius Sheets	Contact Loads: Distributed Watthours Time A	Contact Loads: Distributed Watthours Time B	Contact Loads: Distributed Watthours Time C	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts	No-Contact Loads: Distributed Watthours Time A	No-Contact Loads: Distributed Watthours Time B	No-Contact Loads: Distributed Watthours Time C	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Totals for Existing Loads, Page 1	159,964	56,755	56,755	273,474	28,990	92,791	-	-	92,791	14,881	366,265	43,871
Totals for Future Loads, Page 2												
Total Load Distribution	**159,964**	**56,755**	**56,755**	**273,474**	**28,990**	**92,791**	**-**	**-**	**92,791**	**14,881**	**366,265**	**43,871**
Charger Operating Times (Hours for **A Contact** automatically equal hours for **A No contact**, etc.)	8	8	8			8	8	8				

Reconfigure Loads based on when the Charger is Operating	Contact Loads Distributed Watthours Time A	Time B	Time C		No-Contact Loads Distributed Watthours Time A	Time B	Time C	
Loads While Charger is Operating	159,964	56,755	56,755		92,791	-	-	
Loads While Charger is NOT Operating	-	-	-		-	-	-	

	Contact Loads					No-Contact Loads					Grand Totals	
		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Totals to be used in Battery and Charger Sizing Design		273,474	-	273,474	28,990		92,791	-	92,791	14,881	366,265	43,871
Error Check (Green = OK)				-	-				-	-	-	-

D.3.5 Efficiencies

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name INS IMMUNOLOGY AND VIROLOGY REFERENCE LAB

System Efficiencies and Inputs

User Entries only in Column D

Description	Eff ή %	Discussion	Default Value %	
Values Used in Battery and Charger Sizing				
Battery	80%	Eff for change from Chemical to Electrical energy. 80% to 85% for Lead Acid	80%	a
Inverter	90%	Inverter Efficiencies peak higher but generally at full to maximum loads.	90%	b
Charger - in Inverter / Charger	80%	The charger section is generally less efficient than the inverter section.	80%	c
AC Wiring	97%	Assuming efficient wiring design	97%	d
Depth of Discharge	50%		50%	e
Days of Autonomy	1		1	f
Values Used in PV Array Sizing				

Charge Controller	96%	Assume MPPT Charge Controller	95%	g
DC Wiring	97%	Assume efficient wiring design	97%	h
Panel Mult. Factors	92%	Includes adjustments for nameplate ratings, panel mismatch, dust.	88%	i
Temperature Factor	85%	Ambient of 30 deg = 15%: 35 deg = 83.5%	84%	j
System Voltage (DC)	48		48	
PSH for Design	5.5	Mozambique PSH = 5.0 to 5.5	6	
System Voltage (AC - 2Ph)	220	Mozambique = 220V; ROW - 230VAC	120	
Resulting System Efficiencies **Battery Sizing Inputs**			**Contact Loads**	**No Contact Loads**
While Charging is in Operation				
		No load on the battery for Contact Loads	N/A	
		Charger, Inverter, AC Wiring (b,c,d,)		70%
While Charging is NOT in Operation				
		Battery, Inverter AC Wiring (a,b,d)	70%	70%

D.3.6 Batty-Chrgr Sizing

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name INS IMMUNOLOGY AND VIROLOGY REFERENCE LAB

No luser Inputs on this Sheet

Battery & Charger Sizing

Values Carried over from Charging Scenarios			Contact Loads: Distributed Watthours Charging On	Contact Loads: Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts		No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Required AC Values at Load	AC	-	273,474	-	273,474	28,990	-	92,791	-	92,791	14,881	366,265	43,871
Adjust for Inverter and Battery	DC			-					-				
Adjust for Inverter and Charger	DC							132,862					
No Adjustment Needed	AC		273,474										
Battery Sizing			0.00%										
Total WHR Loads during no charging source	DC		-										

Values Carried over from Charging Scenarios		Contact Loads				No-Contact Loads				Grand Totals	
		Distributed Watthours		Total	Total	Distributed Watthours		Total	Total	Total	Total
		Charging On	Charging Off	WHRS	Conn Watts	Charging On	Charging Off	WHRS	Conn Watts	WHRS	Conn Watts
System DC Voltage	48										
Total AHR Required in Battery for the loaads during no charging source.		-									
Design Depth of Discharge	50%										
Required AHR required for one Day of Loads		-									
Days of Autonomy	1										
Required Battery Bank Size	AH	-									
Charger Sizing											
Total WHR required by No Contact Loads during Charging	DC	132,862									
System DC Voltage	48										
Required Additional AHR in Charger for No Contact Loads		2,768									
Required AHRS for Battery as Calculated above in Battery Sizing		-									
Adjust for Charger Inefficiency	80%	-									
Total AHR Requirement from Chargers	AHR	2,768									
Plus Safety Margin	1.25	3,460									
Hours of Charging	H	24									
Required Charger Amps	AMPS	144									

D.4 DNAM MINISTRY OF HEALTH

D.4.1 General

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name DNAM MINISTRY OF HEALTH

General Site Information

Item	Input	Remarks
Date of Audit	30 August 2010	10:48 Molecular Biology
Name of Auditor	Arturo Romero P	11:43 Microbiology
Affiliation of Auditor	ENT	
Site Coordinates		
Estimated driving time from Maputo	20 min	reference point Hotel Avenida
Road condition	excellent	
Contact Person at Site:	Bernardete Xavier Rafael	
Phone Number of Contact Persons at Site:	829009070	
Title of Contact Person	Tecnica Professor	
Department	Laboratory	
Type of Facility		Health Center, Hospital, etc.
Number of Patients per day	310 patience per day	
Describe Facility	Ministry of health main building	e.g. Lab, computer center, etc…
For Labs: Is this a Basic, Palliative Care, or ARV lab?		

Item	Input	Remarks
Does this facility have a server?	yes	
Operating Hours of Facility:	0700 to 1530	
Operating Days of Facility:	From Monday to Friday even some weekends too	
Are there air conditioners in use in this facility, or planned to be in use?	There are A/C in all labs and corridors	
Provide roof plan and photo		

D.4.2 Site power

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name	DNAM MINISTRY OF HEALTH

Site Power Supplies

Item	Input	Remarks
Grid		
Is the site connected to grid?	YES it is connected to the grid	

Item	Input	Remarks
If YES, describe when grid is usually ON between the hours of 0700 and 1900 hrs.	24 hours	
If Yes, describe when EDM is usually ON between the hours of 1900 and 0700 hours.	24 hours	
Add any comments regarding the power availability of GRID, power quality of GRID, or any other observations.	Lab's responsible said the facility has a UPS to reduce the voltaje variations and black outs	
DELCO / GENERATOR		
Is the generator for the entire facility, or dedicated to these loads?	no	They have a big UPS
Distance between generator and load center		
From Generator Nameplate:		
Manufacturer and Model No.		
Provide Data for Continuous Power Ratings:		
KVA		
KW		
Power Factor		
Voltage and Phase		
Overall Condition and age of Generator		
Is it connected 1-Phase or 3-Phase		
How many hours/day does it run?		
How much fuel per hour or per day does it consume?		
Diameter of wires (feeder) to LC		
Overall wiring of the facility		
Is there a Grounding system?		
Provide Photos of Generator		

NOTES:

D.4.3 Cont & nc loads

Facility Name **DNAM MINISTRY OF HEALTH**

Existing Loads

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	**QTY**	**Load**	**Watts Each**	**Hrs per Day Day**	**Night**	**Hrs per Day Day**	**Night**	**Watthours Day**	**Watthours Night**	**Watthours Day**	**Watthours Night**	**Contact Watthrs Total**	**No-Contact Watthrs Total**	**Cont Total Conn Watts**	**NC Total Conn Watts**
Lab Diagnostico Malaria	5	Microscope	25			5		-	-	625	-	-	625	-	125
INSIDA	10	Computer DELL + UPS	250			8		-	-	20,000	-	-	20,000	-	2,500
	2	Printer	55	3				330	-	-	-	330	-	110	-
Molecular Biology	3	Thermocicladora Oppender	500	5				7,500	-	-	-	7,500	-	1,500	-
	1	Thermocicladora Biometra + UPS	500	5				2,500	-	-	-	2,500	-	500	-
	1	Centrifuge	600	5				3,000	-	-	-	3,000	-	600	-
	1	Centrifuge	600	5				3,000	-	-	-	3,000	-	600	-
	1	Centrifuge	600	5				3,000	-	-	-	3,000	-	600	-
	2	Water Bath	1250	5				12,500	-	-	-	12,500	-	2,500	-
	2	Refrigerator	250	4	9			2,000	4,500	-	-	6,500	-	500	-

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
	1	Ultraviolet light	35	6				210	-	-	-	210	-	35	-
	1	Flujo Laminar Indelab.	3600	8				28,800	-	-	-	28,800	-	3,600	-
	1	Minibis pro Gel Quant (4 amp @ 110 V)	440			4		-	-	1,760	-	-	1,760	-	440
	1	Microwave Oven	1700	3				5,100	-	-	-	5,100	-	1,700	-
	2	Electroforesis 1010	610	5				6,100	-	-	-	6,100	-	1,220	-
	1	Scales (Bascula)	110	2				220	-	-	-	220	-	110	-
	1	PH meter	110	3				330	-	-	-	330	-	110	-
	1	Centrifuge	600	5				3,000	-	-	-	3,000	-	600	-
	1	Magnetic Stirrer	78.8	3				236	-	-	-	236	-	79	-
Microbiology	1	Autoclave	3520	4				14,080	-	-	-	14,080	-	3,520	-
	1	Stirrer (plaques)	30	4				120	-	-	-	120	-	30	-
	1	Electrical heater	700	5				3,500	-	-	-	3,500	-	700	-
	1	incubator Memmert S	800	5	10			4,000	8,000	-	-	12,000	-	800	-
	1	Scales (Bascula)	110	2				220	-	-	-	220	-	110	-
	1	Incubator	4000	5	10			20,000	40,000	-	-	60,000	-	4,000	-
	1	Incubator	800	5	10			4,000	8,000	-	-	12,000	-	800	-
	1	Refrigerator DAIREI	250	4	9			1,000	2,250	-	-	3,250	-	250	-

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day		Hrs per Day		Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
				Day	Night	Day	Night								
	1	Refrigerator ARISTON	250	4	9			1,000	2,250	-	-	3,250	-	250	-
	2	Refrigerator FLOCCHETTI	250	4	9			2,000	4,500	-	-	6,500	-	500	-
	1	Refrigerator AS Angelaton	250	4	9			1,000	2,250	-	-	3,250	-	250	-
								-	-	-	-	-	-	-	-
Grand Totals								128,746	71,750	22,385	-	200,496	22,385	25,574	3,065

Total contact & no-contact WHrs	222,881
Total contact & no-contact Ahrs	4,643.36
Number of Strings of 8 rolls 6V 350AH Batty	13.27

D.4.4 Charging sc

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name: DNAM MINISTRY OF HEALTH

Charging Scenarios

Carry Forward Load Information From Previoius Sheets	Contact Loads Distributed Watthours Time A	Time B	Time C	Total WHRS	Total Conn Watts	No-Contact Loads Distributed Watthours Time A	Time B	Time C	Total WHRS	Total Conn Watts	Grand Totals Total WHRS	Total Conn Watts
Totals for Existing Loads, Page 1	128,746	35,875	35,875	200,496	25,574	22,385	-	-	22,385	3,065	222,881	28,639
Totals for Future Loads, Page 2												
Total Load Distribution	**128,746**	**35,875**	**35,875**	**200,496**	**25,574**	**22,385**	**-**	**-**	**22,385**	**3,065**	**222,881**	**28,639**
Charger Operating Times (Hours for **A Contact** automatically equal hours for **A No contact**, etc.)	8	8	8			8	8	8				
Reconfigure Loads based on	Contact Loads Distributed Watthours					No-Contact Loads Distributed Watthours						

when the Charger is Operating	Time A	Time B	Time C		Time A	Time B	Time C	
Loads While Charger is Operating	128,746	35,875	35,875		22,385	-	-	
Loads While Charger is NOT Operating	-	-	-		-	-	-	

	Contact Loads					No-Contact Loads					Grand Totals	
		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Totals to be used in Battery and Charger Sizing Design		200,496	-	200,496	25,574		22,385	-	22,385	3,065	222,881	28,639
Error Check (Green = OK)				-	-				-	-	-	-

D.4.5 Efficiencies

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name DNAM MINISTRY OF HEALTH

System Efficiencies and Inputs

User Entries only in Column D

Description	Eff ή %	Discussion	Default Value %					
Values Used in Battery and Charger Sizing								
Battery	80%	Eff for change from Chemical to Electrical energy. 80% to 85% for Lead Acid	80%	a				
Inverter	90%	Inverter Efficiencies peak higher but generally at full to maximum loads.	90%	b				
Charger - in Inverter / Charger	80%	The charger section is generally less efficient than the inverter section.	80%	c				
AC Wiring	97%	Assuming efficient wiring design	97%	d				
Depth of Discharge	50%		50%	e				
Days of Autonomy	1		1	f				

Values Used in PV Array Sizing				
Charge Controller	96%	Assume MPPT Charge Controller	95%	g
DC Wiring	97%	Assume efficient wiring design	97%	h
Panel Mult. Factors	92%	Includes adjustments for nameplate ratings, panel mismatch, dust.	88%	i
Temperature Factor	85%	Ambient of 30 deg = 15%: 35 deg = 83.5%	84%	j
System Voltage (DC)	48		48	
PSH for Design	5.5	Mozambique PSH = 5.0 to 5.5	6	
System Voltage (AC - 2Ph)	220	Mozambique = 220V; ROW - 230VAC	120	
Resulting System Efficiencies			**Contact Loads**	**No Contact Loads**
Battery Sizing Inputs				
While Charging is in Operation				
		No load on the battery for Contact Loads	N/A	
		Charger, Inverter, AC Wiring (b,c,d,)		70%
While Charging is NOT in Operation				
		Battery, Inverter AC Wiring (a,b,d)	70%	70%

D.4.6 Batty-chrgh sizing

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name DNAM MINISTRY OF HEALTH

No Iuser Inputs on this Sheet

Battery & Charger Sizing

Values Carried over from Charging Scenarios			Contact Loads: Distributed Watthours Charging On	Contact Loads: Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts		No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Required AC Values at Load	AC	-	200,496	-	200,496	25,574	-	22,385	-	22,385	3,065	222,881	28,639
Adjust for Inverter and Battery	DC			-					-				
Adjust for Inverter and Charger	DC							32,052					
No Adjustment Needed	AC		200,496										
Battery Sizing			**0.00%**										
Total WHR Loads during no charging source	DC		-										
System DC Voltage	48												

Values Carried over from Charging Scenarios		Contact Loads				No-Contact Loads				Grand Totals	
		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Total AHR Required in Battery for the loaads during no charging source.		-									
Design Depth of Discharge	50%										
Required AHR required for one Day of Loads		-									
Days of Autonomy	1										
Required Battery Bank Size	AH	-									
Charger Sizing											
Total WHR required by No Contact Loads during Charging	DC	32,052									
System DC Voltage	48										
Required Additional AHR in Charger for No Contact Loads		668									
Required AHRS for Battery as Calculated above in Battery Sizing		-									
Adjust for Charger Inefficiency	80%	-									
Total AHR Requirement from Chargers	AHR	668									
Plus Safety Margin	1.25	835									
Hours of Charging	H	24									
Required Charger Amps	AMPS	35									

D.5 HOSPITAL GENERAL MAVALANE

D.5.1 General

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name HOSPITAL GENERAL MAVALANE

General Site Information

Item	Input	Remarks
Date of Audit	August 24th and 25th, 2010	10:20 a.m.
Name of Auditor	Arturo Romero P	
Affiliation of Auditor	ENT	
Site Coordinates		
Estimated driving time from Maputo	30 minutes	Reference point: Hotel Avenida
Road condition	excellent	
Contact Person at Site:	Sutana Da Cruz	
Phone Number of Contact Persons at Site:	824417300	
Title of Contact Person	Responsible in the Laboratory	
Department	Laboratory	
Type of Facility	Laboratory of the Hospital	Health Center, Hospital, etc.
Number of Patients per day	300 patience per day	
Describe Facility	it is the laboratory of the hospital	e.g. Lab, computer center, etc…
For Labs: Is this a Basic, Palliative Care, or ARV lab?		
Does this facility have a server?	yes	

Item	Input	Remarks
Operating Hours of Facility:	0700 to 1530	
Operating Days of Facility:	From Monday to Friday even some weekends too	
Are there air conditioners in use in this facility, or planned to be in use?	YES there are 7 equipments	
Provide roof plan and photo	go to Photo album in apendix.	

D.5.2 Site power

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name HOSPITAL GENERAL MAVALANE

Site Power Supplies

Item	Input	Remarks
Grid		
Is the site connected to grid?	YES it is connected to the grid	
If YES, describe when grid is usually ON between the hours of 0700 and 1900 hrs.	24 hours	
If Yes, describe when EDM is usually ON between the hours of 1900 and 0700 hours.	24 hours	
Add any comments regarding the power availability of GRID, power quality of GRID, or any other observations.	Lab's responsible argues low quality of service due the voltaje variations and black outs	
DELCO / GENERATOR		
Is the generator for the entire facility, or dedicated to these loads?	there is a genset as a back up for the whole hospital	
Distance between generator and load center	about 50 meters	
From Generator Nameplate:		
Manufacturer and Model No.	Perkins	
Provide Data for Continuous Power Ratings:		
KVA	170	
KW	168	
Power Factor		

Item	Input	Remarks
Voltage and Phase	220 V / 3 phases	
Overall Condition and age of Generator	regular conditions in general	Just 316 hours of use since 2008
Is it connected 1-Phase or 3-Phase	3	
How many hours/day does it run?		
How much fuel per hour or per day does it consume?	it is variable - they have a 60 liters container in use	
Diameter of wires (feeder) to LC	it is 1/0	
Overall wiring of the facility	Good	
Is there a Grounding system?	yes	
Provide Photos of Generator	go to Photo album in apendix.	

NOTES:

D.5.3 Cont & nc loads

Facility Name HOSPITAL GENERAL MAVALANE

Existing Loads

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
Biochemistry	1	Refrigerator (horizontal)	210	4	9			840	1,890	-	-	2,730	-	210	-
	3	Refrigerator for "reagents" (Vertical) [farmacy and drugstore app]	180	4	9			2,160	4,860	-	-	7,020	-	540	-
	1	Refrigerator- domestic type (Vertical)	250	4	9			1,000	2,250	-	-	3,250	-	250	-
	3	Microscope	25			5		-	-	375	-	-	375	-	75
	1	Printer HP 1200	252	3				756	-	-	-	756	-	252	-
	2	Printer OKI B4300	250	3				1,500	-	-	-	1,500	-	500	-
	1	Bechman Coulter Erics XL MCL	2200			6		-	-	13,200	-	-	13,200	-	2,200
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
	1	Computer MECER	300			8		-	-	2,400	-	-	2,400	-	300
	1	Water Bath Labcon	2000	5				10,000	-	-	-	10,000	-	2,000	-
	1	Water bath Equitron	1000	5				5,000	-	-	-	5,000	-	1,000	-

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	**QTY**	**Load**	**Watts Each**	**Hrs per Day Day**	**Night**	**Hrs per Day Day**	**Night**	**Watthours Day**	**Watthours Night**	**Watthours Day**	**Watthours Night**	**Contact Watthrs Total**	**No-Contact Watthrs Total**	**Cont Total Conn Watts**	**NC Total Conn Watts**
	1	Stirrer VAN 250	11	4				44	-	-	-	44	-	11	-
	1	Centrifuge PLC	180	5				900	-	-	-	900	-	180	-
	1	Water distiller	1000	5				5,000	-	-	-	5,000	-	1,000	-
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
	1	Printer Sansung	50	3				150	-	-	-	150	-	50	-
	1	ABX Pentra 400 + UPS (+ 450 W Refrigerator)	1000			6		-	-	6,000	-	-	6,000	-	1,000
	1	Printer HP	75	3				225	-	-	-	225	-	75	-
	1	Ethylen Glycol	450	7				3,150	-	-	-	3,150	-	450	-
	1	Cobas Integra 400 + UPS	1200			7		-	-	8,400	-	-	8,400	-	1,200
	1	Computer HP + UPS	250			8		-	-	2,000	-	-	2,000	-	250
Microbiology	1	Refrigerator Servibar	200	4	9			800	1,800	-	-	2,600	-	200	-
	1	Scales (Bascula)	110	2				220	-	-	-	220	-	110	-
	1	Microscope	25			5		-	-	125	-	-	125	-	25
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
	1	Incubator SCIENTIFIC (22 A, 220 Vca)	4840	5	10			24,200	48,400	-	-	72,600	-	4,840	-
	1	Cabine Bio2 Cab	1800	8				14,400	-	-	-	14,400	-	1,800	-
CD4	1	Cabine Bio2 Cab	1800	8				14,400	-	-	-	14,400	-	1,800	-

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
	1	Server Dell + UPS	200			8		-	-	1,600	-	-	1,600	-	200
	1	Printer HP	75	3				225	-	-	-	225	-	75	-
	1	Computer MAC + UPS	300			8		-	-	2,400	-	-	2,400	-	300
	1	BD FACS Calibur + computer+printer + UPS	1725			6		-	-	10,350	-	-	10,350	-	1,725
	1	Stirrer VAN 250	11	4				44	-	-	-	44	-	11	-
	1	Oven serie 2000 Scientific	2000	5	10			10,000	20,000	-	-	30,000	-	2,000	-
Esterizacion	1	Autoclave	3520	4				14,080	-	-	-	14,080	-	3,520	-
	1	Mircowave oven Logik	1400	3				4,200	-	-	-	4,200	-	1,400	-
	1	Incubator SCIENTIFIC	4840	5	10			24,200	48,400	-	-	72,600	-	4,840	-
	1	Stove	1250	6				7,500	-	-	-	7,500	-	1,250	-
	1	Centrifuge PLC	180	5				900	-	-	-	900	-	180	-
Reception	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
	1	Printer DELL	550	3				1,650	-	-	-	1,650	-	550	-
								-	-	-	-	-	-	-	-
								-	-	-	-	-	-	-	-
								-	-	-	-	-	-	-	-

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Hrs per Day Night	Hrs per Day Day	Hrs per Day Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
Grand Totals								147,544	127,600	54,850	-	275,144	54,850	29,094	8,275

Total contact & no-contact WHrs	329,994
Total contact & no-contact Ahrs	6,874.88
Number of Strings of 8 rolls 6V 350AH Batty	19.64

D.5.4 Charging

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL GENERAL MAVALANE

Charging Scenarios

Carry Forward Load Information From Previoius Sheets	Contact Loads					No-Contact Loads					Grand Totals	
	Distributed Watthours			Total	Total	Distributed Watthours			Total	Total	Total	Total
	Time A	Time B	Time C	WHRS	Conn Watts	Time A	Time B	Time C	WHRS	Conn Watts	WHRS	Conn Watts
Totals for Existing Loads, Page 1	147,544	63,800	63,800	275,144	29,094	54,850	-	-	54,850	8,275	329,994	37,369
Totals for Future Loads, Page 2												
Total Load Distribution	**147,544**	**63,800**	**63,800**	**275,144**	**29,094**	**54,850**	**-**	**-**	**54,850**	**8,275**	**329,994**	**37,369**
Charger Operating Times (Hours for **A Contact** automatically equal hours for **A No contact**, etc.)	8	8	8			8	8	8				
Reconfigure Loads based on when the Charger is Operating	Contact Loads Distributed Watthours					No-Contact Loads Distributed Watthours						
	Time	Time	Time			Time	Time	Time				

	A	B	C		A	B	C	
Loads While Charger is Operating	147,544	63,800	63,800		54,850	-	-	
Loads While Charger is NOT Operating	-	-	-		-	-	-	

	Contact Loads				No-Contact Loads				Grand Totals	
	Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Totals to be used in Battery and Charger Sizing Design	275,144	-	275,144	29,094	54,850	-	54,850	8,275	329,994	37,369
Error Check (Green = OK)			-	-			-	-	-	-

D.5.5 Effciencies

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL GENERAL MAVALANE

System Efficiencies and Inputs

User Entries only in Column D

Description	Eff ή %	Discussion	Default Value %					
Values Used in Battery and Charger Sizing								
Battery	80%	Eff for change from Chemical to Electrical energy. 80% to 85% for Lead Acid	80%	a				
Inverter	90%	Inverter Efficiencies peak higher but generally at full to maximum loads.	90%	b				
Charger - in Inverter / Charger	80%	The charger section is generally less efficient than the inverter section.	80%	c				
AC Wiring	97%	Assuming efficient wiring design	97%	d				
Depth of Discharge	50%		50%	e				
Days of Autonomy	1		1	f				

Description	Eff ή %	Discussion	Default Value %	
Values Used in PV Array Sizing				
Charge Controller	96%	Assume MPPT Charge Controller	95%	g
DC Wiring	97%	Assume efficient wiring design	97%	h
Panel Mult. Factors	92%	Includes adjustments for nameplate ratings, panel mismatch, dust.	88%	i
Temperature Factor	85%	Ambient of 30 deg = 15%: 35 deg = 83.5%	84%	j
System Voltage (DC)	48		48	
PSH for Design	5.5	Mozambique PSH = 5.0 to 5.5	6	
System Voltage (AC - 2Ph)	220	Mozambique = 220V; ROW - 230VAC	120	
Resulting System Efficiencies **Battery Sizing Inputs**			**Contact Loads**	**No Contact Loads**
While Charging is in Operation				
		No load on the battery for Contact Loads	N/A	
		Charger, Inverter, AC Wiring (b,c,d,)		70%
While Charging is NOT in Operation				
		Battery, Inverter AC Wiring (a,b,d)	70%	70%

D.5.6 Batty-chrgr sizing

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL GENERAL MAVALANE

No Iuser Inputs on this Sheet

Battery & Charger Sizing

Values Carried over from Charging Scenarios			Contact Loads: Distributed Watthours Charging On	Contact Loads: Distributed Watthours Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts		No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Distributed Watthours Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Required AC Values at Load	AC	-	275,144	-	275,144	29,094	-	54,850	-	54,850	8,275	329,994	37,369
Adjust for Inverter and Battery	DC			-					-				
Adjust for Inverter and Charger	DC							78,537					
No Adjustment Needed	AC		275,144										
Battery Sizing			**0.00%**										
Total WHR Loads during no charging source	DC		-										
System DC Voltage	48												

Values Carried over from Charging Scenarios		Contact Loads: Distributed Watthours Charging On	Contact Loads: Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts	No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Total AHR Required in Battery for the loaads during no charging source.		-									
Design Depth of Discharge	50%										
Required AHR required for one Day of Loads		-									
Days of Autonomy	1										
Required Battery Bank Size	AH	-									
Charger Sizing											
Total WHR required by No Contact Loads during Charging	DC	78,537									
System DC Voltage	48										
Required Additional AHR in Charger for No Contact Loads		1,636									
Required AHRS for Battery as Calculated above in Battery Sizing		-									
Adjust for Charger Inefficiency	80%	-									
Total AHR Requirement from Chargers	AHR	1,636									
Plus Safety Margin	1.25	2,045									
Hours of Charging	H	24									
Required Charger Amps	AMPS	85									

D.6 HOSPITAL MILITARY

D.6.1 General

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name HOSPITAL MILITARY

General Site Information

Item	Input	Remarks
Date of Audit	August 26th and 27th, 2010	03:24 p.m.
Name of Auditor	Arturo Romero P	
Affiliation of Auditor	ENT	
Site Coordinates		
Estimated driving time from Maputo	30 minutes	Reference point: Hotel Avenida
Road condition	excellent	
Contact Person at Site:	Joao Albano Mabunda	
Phone Number of Contact Persons at Site:	258 826399260	
Title of Contact Person	Responsible in the Laboratory	
Department	Laboratory	
Type of Facility	Laboratory of the Hospital	Health Center, Hospital, etc.
Number of Patients per day	310 patience per day	
Describe Facility	it is the laboratory of the hospital	e.g. Lab, computer center, etc…
For Labs: Is this a Basic, Palliative Care, or ARV lab?		
Does this facility have a server?	yes	

Item	Input	Remarks
Operating Hours of Facility:	0700 to 1530	
Operating Days of Facility:	From Monday to Friday even some weekends too	
Are there air conditioners in use in this facility, or planned to be in use?	there are 5 equipments	
Provide roof plan and photo	go to Photo album in apendix.	

D.6.2 Site power

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name HOSPITAL MILITARY

Site Power Supplies

Item	Input	Remarks
Grid		
Is the site connected to grid?	YES it is connected to the grid	
If YES, describe when grid is usually ON between the hours of 0700 and 1900 hrs.	24 hours	
If Yes, describe when EDM is usually ON between the hours of 1900 and 0700 hours.	24 hours	
Add any comments regarding the power availability of GRID, power quality of GRID, or any other observations.	Lab's responsible argues low quality of service due the voltaje variations and black outs	
DELCO / GENERATOR		
Is the generator for the entire facility, or dedicated to these loads?	there is a genset as a back up for the whole hospital	
Distance between generator and load center	about 50 meters	
From Generator Nameplate:		
Manufacturer and Model No.	Perkins	
Provide Data for Continuous Power Ratings:		
KVA	170	
KW	168	
Power Factor		
Voltage and Phase	220 V / 3 phases	
Overall Condition and age of Generator	regular conditions in general	Just 316 hours of use since 2008

Item	Input	Remarks
Is it connected 1-Phase or 3-Phase	3	
How many hours/day does it run?		
How much fuel per hour or per day does it consume?	it is variable - they have a 60 liters container in use	
Diameter of wires (feeder) to LC	it is 1/0	
Overall wiring of the facility	Good	
Is there a Grounding system?	yes	
Provide Photos of Generator	go to Photo album in apendix.	

NOTES:

D.6.3 Cont & nc Loads

Facility Name **HOSPITAL MILITARY**

Existing Loads

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
Prioritary	2	Sysmex XT 2000 i	184			4		-	-	1,472	-	-	1,472	-	368
	1	Microscope	25			5		-	-	125	-	-	125	-	25
	1	centrifuge	600	5				3,000	-	-	-	3,000	-	600	-
	1	ABX Pentra 400 + UPS (+ 450 W Refrigerator)	1000			6		-	-	6,000	-	-	6,000	-	1,000
	1	BD FACS Calibur + computer+printer + UPS	1725			6		-	-	10,350	-	-	10,350	-	1,725
	1	LIS	100	4				400	-	-	-	400	-	100	-
	2	Computer	250			8		-	-	4,000	-	-	4,000	-	500
Sala de lavagem	1	memmert ULM 500 230 V 8.7 A	2000	5	10			10,000	20,000	-	-	30,000	-	2,000	-
	1	memmert BE 500 230 V 3.9 A	900	5	10			4,500	9,000	-	-	13,500	-	900	-
	2	unicleve 88	6000	4				48,000	-	-	-	48,000	-	12,000	-
	1	Centrifuge Universal 32 Hettich	286	5				1,430	-	-	-	1,430	-	286	-

Area	QTY	Load	Watts Each	Contact Hrs per Day Day	Contact Hrs per Day Night	No contact Hrs per Day Day	No contact Hrs per Day Night	Contact Loads Watthours Day	Contact Loads Watthours Night	No-contact loads Watthours Day	No-contact loads Watthours Night	Watt-hours Contact Watthrs Total	Watt-hours No-Contact Watthrs Total	Watts Cont Total Conn Watts	Watts NC Total Conn Watts
Main Room	1	UPS inv invertomatic	45	8				360	-	-	-	360	-	45	-
	2	Sysmex KX 21N	184			4		-	-	1,472	-	-	1,472	-	368
	1	Sysmex KX 21N	184			4		-	-	736	-	-	736	-	184
	1	Centrifuge Hereaus	180	5				900	-	-	-	900	-	180	-
	1	freezer 1.8m ARCOIBA	350	4	9			1,400	3,150	-	-	4,550	-	350	-
	3	Computer	250			8		-	-	6,000	-	-	6,000	-	750
Microbiology	1	Bio Cab extraction campana	500	8				4,000	-	-	-	4,000	-	500	-
	1	Oven B12 Hereaus	2000	5	10			10,000	20,000	-	-	30,000	-	2,000	-
	1	Refrigerator GE Mid size	250	4	9			1,000	2,250	-	-	3,250	-	250	-
	1	Computer	250			8		-	-	2,000	-	-	2,000	-	250
	1	Microscopes Olympus	55			5		-	-	275	-	-	275	-	55
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
Serology	1	Shaker VRN 200	30	4				120	-	-	-	120	-	30	-
	1	Flexon Junior	200			5		-	-	1,000	-	-	1,000	-	200
	1	Heraus Megafluge 1.0	700	4				2,800	-	-	-	2,800	-	700	-
	2	Printer HP laser	450	3				2,700	-	-	-	2,700	-	900	-
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250

Area	QTY	Load	Watts Each	Contact Hrs per Day Day	Contact Hrs per Day Night	No contact Hrs per Day Day	No contact Hrs per Day Night	Contact Loads Watthours Day	Contact Loads Watthours Night	No-contact loads Watthours Day	No-contact loads Watthours Night	Watt-hours Contact Watthrs Total	Watt-hours No-Contact Watthrs Total	Watts Cont Total Conn Watts	Watts NC Total Conn Watts
	1	mini Vidas	352			4		-	-	1,408	-	-	1,408	-	352
	1	ABX Pentra 400 + UPS (+ 450 W Refrigerator)	1000			6		-	-	6,000	-	-	6,000	-	1,000
Imunology	1	Bechman densitometer	440			6		-	-	2,640	-	-	2,640	-	440
	1	Diagnostico Stayo	110			6		-	-	660	-	-	660	-	110
	2	Electroforesis 1010	610	6				7,320	-	-	-	7,320	-	1,220	-
	1	BD FACS Calibur + computer+printer + UPS	1725			6		-	-	10,350	-	-	10,350	-	1,725
	3	Computer DELL + UPS	250			8		-	-	6,000	-	-	6,000	-	750
	2	Refrigerator GE Mid size	250	4	9			2,000	4,500	-	-	6,500	-	500	-
	1	Refrigerator Fiachetti	350	4	9			1,400	3,150	-	-	4,550	-	350	-
								-	-	-	-	-	-	-	-
Grand Totals								**101,330**	**62,050**	**64,488**	**-**	**163,380**	**64,488**	**22,911**	**10,302**

Total contact & no-contact WHrs	227,868
Total contact & no-contact Ahrs	4,747.25
Number of Strings of 8 rolls 6V 350AH Batty	13.56

D.6.4 Charging SC

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL MILITARY

Charging Scenarios

Carry Forward Load Information From Previoius Sheets	Contact Loads: Distributed Watthours Time A	Contact Loads: Distributed Watthours Time B	Contact Loads: Distributed Watthours Time C	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts	No-Contact Loads: Distributed Watthours Time A	No-Contact Loads: Distributed Watthours Time B	No-Contact Loads: Distributed Watthours Time C	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Totals for Existing Loads, Page 1	101,330	31,025	31,025	163,380	22,911	64,488	-	-	64,488	10,302	227,868	33,213
Totals for Future Loads, Page 2												
Total Load Distribution	**101,330**	**31,025**	**31,025**	**163,380**	**22,911**	**64,488**	**-**	**-**	**64,488**	**10,302**	**227,868**	**33,213**
Charger Operating Times (Hours for **A Contact** automatically equal hours for **A No contact**, etc.)	8	8	8			8	8	8				
	Contact Loads					**No-Contact Loads**						

Reconfigure Loads based on when the Charger is Operating	Distributed Watthours Time A	Time B	Time C		Distributed Watthours Time A	Time B	Time C	
Loads While Charger is Operating	101,330	31,025	31,025		64,488	-	-	
Loads While Charger is NOT Operating	-	-	-		-	-	-	

	Contact Loads					No-Contact Loads					Grand Totals	
		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Totals to be used in Battery and Charger Sizing Design		163,380	-	163,380	22,911		64,488	-	64,488	10,302	227,868	33,213
Error Check (Green = OK)				-	-				-	-	-	-

D.6.5 Efficiencies

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

HOSPITAL MILITARY

User Entries only in Column D

Description	Eff ή %	Discussion	Default Value %					
Values Used in Battery and Charger Sizing								
Battery	80%	Eff for change from Chemical to Electrical energy. 80% to 85% for Lead Acid	80%	a				
Inverter	90%	Inverter Efficiencies peak higher but generally at full to maximum loads.	90%	b				
Charger - in Inverter / Charger	80%	The charger section is generally less efficient than the inverter section.	80%	c				
AC Wiring	97%	Assuming efficient wiring design	97%	d				
Depth of Discharge	50%		50%	e				
Days of Autonomy	1		1	f				
Values Used in PV Array Sizing								

Charge Controller	96%	Assume MPPT Charge Controller	95%	g
DC Wiring	97%	Assume efficient wiring design	97%	h
Panel Mult. Factors	92%	Includes adjustments for nameplate ratings, panel mismatch, dust.	88%	i
Temperature Factor	85%	Ambient of 30 deg = 15%: 35 deg = 83.5%	84%	j
System Voltage (DC)	48		48	
PSH for Design	5.5	Mozambique PSH = 5.0 to 5.5	6	
System Voltage (AC - 2Ph)	220	Mozambique = 220V; ROW - 230VAC	120	
Resulting System Efficiencies **Battery Sizing Inputs**			**Contact Loads**	**No Contact Loads**
While Charging is in Operation				
		No load on the battery for Contact Loads	N/A	
		Charger, Inverter, AC Wiring (b,c,d,)		70%
While Charging is NOT in Operation				
		Battery, Inverter AC Wiring (a,b,d)	70%	70%

D.6.6 Batty-chrgh sizing

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL MILITARY

No Iuser Inputs on this Sheet

Battery & Charger Sizing

Values Carried over from Charging Scenarios			Contact Loads					No-Contact Loads				Grand Totals	
			Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Required AC Values at Load	AC	-	163,380	-	163,380	22,911	-	64,488	-	64,488	10,302	227,868	33,213
Adjust for Inverter and Battery	DC			-					-				
Adjust for Inverter and Charger	DC							92,337					
No Adjustment Needed	AC		163,380										
Battery Sizing			**0.00%**										
Total WHR Loads during no charging source	DC		-										
System DC Voltage	48												

Values Carried over from Charging Scenarios		Contact Loads: Distributed Watthours Charging On	Contact Loads: Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts	No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Total AHR Required in Battery for the loaads during no charging source.		-									
Design Depth of Discharge	50%										
Required AHR required for one Day of Loads		-									
Days of Autonomy	1										
Required Battery Bank Size	AH	-									
Charger Sizing											
Total WHR required by No Contact Loads during Charging	DC	92,337									
System DC Voltage	48										
Required Additional AHR in Charger for No Contact Loads		1,924									
Required AHRS for Battery as Calculated above in Battery Sizing		-									
Adjust for Charger Inefficiency	80%	-									
Total AHR Requirement from Chargers	AHR	1,924									
Plus Safety Margin	1.25	2,405									
Hours of Charging	H	24									
Required Charger Amps	AMPS	100									

D.7 HOSPITAL GENERAL XAI XAI

D.7.1 General

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL GENERAL XAI XAI

General Site Information

Item	Input	Remarks
Date of Audit	August 30th, 2010	10:20 a.m.
Name of Auditor	Arturo Romero P	
Affiliation of Auditor	ENT	
Site Coordinates		
Estimated driving time from Maputo	180 minutes	Reference point: Hotel Avenida
Road condition	excellent mostly all read	
Contact Person at Site:	Domingus Machova	
Phone Number of Contact Persons at Site:		
Title of Contact Person	Responsible in the Laboratory	
Department	Laboratory	
Type of Facility	Laboratory of the Hospital	Health Center, Hospital, etc.
Number of Patients per day	580 samples per day	
Describe Facility	it is the laboratory of the hospital	e.g. Lab, computer center, etc...
For Labs: Is this a Basic, Palliative Care, or ARV lab?		
Does this facility have a server?	yes	

Item	Input	Remarks
Operating Hours of Facility:	0700 to 1530	
Operating Days of Facility:	From Monday to Friday even some weekends too	
Are there air conditioners in use in this facility, or planned to be in use?	YES there are 8 equipments	
Provide roof plan and photo	go to Photo album in apendix.	

D.7.2 Site power

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name HOSPITAL GENERAL XAI XAI

Site Power Supplies

Item	Input	Remarks
Grid		
Is the site connected to grid?	YES it is connected to the grid	
If YES, describe when grid is usually ON between the hours of 0700 and 1900 hrs.	24 hours	
If Yes, describe when EDM is usually ON between the hours of 1900 and 0700 hours.	24 hours	
Add any comments regarding the power availability of GRID, power quality of GRID, or any other observations.	Lab's responsible argues low quality of service due the voltaje variations and black outs	
DELCO / GENERATOR		
Is the generator for the entire facility, or dedicated to these loads?	there is a genset as a back up for the whole hospital	
Distance between generator and load center	45 meters	
From Generator Nameplate:	40 meters	
Manufacturer and Model No.	Caterpillar 168 kW	
Provide Data for Continuous Power Ratings:		
KVA	170	
KW	168	
Power Factor		

Item	Input	Remarks
Voltage and Phase	220 V / 3 phases	
Overall Condition and age of Generator	good conditions in general, it has been running since late 1999.	Just 316 hours of use since 2008
Is it connected 1-Phase or 3-Phase	3	
How many hours/day does it run?		
How much fuel per hour or per day does it consume?	it is variable - they have a 60 liters container in use	
Diameter of wires (feeder) to LC	it is 1/0	
Overall wiring of the facility	Good	
Is there a Grounding system?	yes	
Provide Photos of Generator	go to Photo album in apendix.	

NOTES: it is not an authomatic operation. When a black out is programed they have been warned prior it ocurres.

D.7.3 Cont & nc loads

Facility Name HOSPITAL GENERAL XAI XAI

Existing Loads

				Contact		No contact		Contact Loads		No-contact loads		Watt-hours		Watts	
Area	QTY	Load	Watts Each	Hrs per Day Day	Night	Hrs per Day Day	Night	Watthours Day	Watthours Night	Watthours Day	Watthours Night	Contact Watthrs Total	No-Contact Watthrs Total	Cont Total Conn Watts	NC Total Conn Watts
Reception	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
	1	Printer DELL	550	3				1,650	-	-	-	1,650	-	550	-
office (inside the lab)	2	Computer DELL + UPS	250			8		-	-	4,000	-	-	4,000	-	500
	3	Printer DELL	550	3				4,950	-	-	-	4,950	-	1,650	-
Biochemistry	1	Stirrer VAN 250	11	4				44	-	-	-	44	-	11	-
	1	Centrifuge PLC	180	5				900	-	-	-	900	-	180	-
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
	1	Printer OKI B4300	250	3				750	-	-	-	750	-	250	-
	1	ABX Pentra 400 + UPS (+ 450 W Refrigerator)	1000			6		-	-	6,000	-	-	6,000	-	1,000
Hematology	1	Printer HP	75	3				225	-	-	-	225	-	75	-
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250

Area	QTY	Load	Watts Each	Contact Hrs per Day: Day	Contact Hrs per Day: Night	No contact Hrs per Day: Day	No contact Hrs per Day: Night	Contact Loads Watthours Day	Contact Loads Watthours Night	No-contact loads Watthours Day	No-contact loads Watthours Night	Watt-hours Contact Watthrs Total	Watt-hours No-Contact Watthrs Total	Watts Cont Total Conn Watts	Watts NC Total Conn Watts
	1	Sysmex XT 2000 i	184			4		-	-	736	-	-	736	-	184
	1	Computer HP + UPS	250			8		-	-	2,000	-	-	2,000	-	250
Pasillo office-Biochemistry	1	Refrigerator Sanyo 1370L model MPR 1410	380	4	9			1,520	3,420	-	-	4,940	-	380	-
	1	Refrigerator "Farmacia" Model AR230 by Friconde LDA, Portugal	210	4	9			840	1,890	-	-	2,730	-	210	-
	1	Rotofix 32 Zentafugon Tettich	110			4		-	-	440	-	-	440	-	110
Pasillo hematology-Biochemistry	3	Refrigerator "Farmacia" Model AR230 by Friconde LDA, Portugal	210	4	9			2,520	5,670	-	-	8,190	-	630	-
	1	Microscope	25			5		-	-	125	-	-	125	-	25
	1	Refrigerator Sanyo 1370L model MPR 1410	380	4	9			1,520	3,420	-	-	4,940	-	380	-
Parasitology	1	cabine de seguranza Labotec	750	8				6,000	-	-	-	6,000	-	750	-
	1	Refrigerator Bosh 260	220	4	9			880	1,980	-	-	2,860	-	220	-
	1	Ecotherm Labotec Oven	2000	6				12,000	-	-	-	12,000	-	2,000	-
	1	Memmert	1000	5	10			5,000	10,000	-	-	15,000	-	1,000	-
	1	Water distiller	1000	5				5,000	-	-	-	5,000	-	1,000	-
	1	Autoclave	3520	4				14,080	-	-	-	14,080	-	3,520	-
Inmunology	1	BD FACS Calibur + computer+printer + UPS	1725			6		-	-	10,350	-	-	10,350	-	1,725
	1	Computer MAC + UPS	300			8		-	-	2,400	-	-	2,400	-	300

Area	QTY	Load	Watts Each	Contact Hrs per Day Day	Contact Hrs per Day Night	No contact Hrs per Day Day	No contact Hrs per Day Night	Contact Loads Watthours Day	Contact Loads Watthours Night	No-contact loads Watthours Day	No-contact loads Watthours Night	Watt-hours Contact Watthrs Total	Watt-hours No-Contact Watthrs Total	Watts Cont Total Conn Watts	Watts NC Total Conn Watts
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
	1	Printer HP 1200	252	3				756	-	-	-	756	-	252	-
	1	Cabine Bio2 Cab	1800	8				14,400	-	-	-	14,400	-	1,800	-
Microbiology	1	Cabine BioFlow II Labotec	750	8				6,000	-	-	-	6,000	-	750	-
	1	Computer DELL + UPS	250			8		-	-	2,000	-	-	2,000	-	250
	1	Microscope	25			5		-	-	125	-	-	125	-	25
	1	Memmert	1000	5	10			5,000	10,000	-	-	15,000	-	1,000	-
								-	-	-	-	-	-	-	-
Grand Totals								**84,035**	**36,380**	**36,176**	**-**	**120,415**	**36,176**	**16,608**	**5,369**

Total contact & no-contact WHrs	156,591
Total contact & no-contact Ahrs	3,262.31
Number of Strings of 8 rolls 6V 350AH Batty	9.32

D.7.4 Charging sc

Site Energy Assessments
MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL GENERAL XAI XAI

Charging Scenarios

Carry Forward Load Information From Previoius Sheets	Contact Loads					No-Contact Loads					Grand Totals	
	Distributed Watthours			Total	Total	Distributed Watthours			Total	Total	Total	Total
	Time A	Time B	Time C	WHRS	Conn Watts	Time A	Time B	Time C	WHRS	Conn Watts	WHRS	Conn Watts
Totals for Existing Loads, Page 1	84,035	18,190	18,190	120,415	16,608	36,176	-	-	36,176	5,369	156,591	21,977
Totals for Future Loads, Page 2												
Total Load Distribution	**84,035**	**18,190**	**18,190**	**120,415**	**16,608**	**36,176**	**-**	**-**	**36,176**	**5,369**	**156,591**	**21,977**
Charger Operating Times (Hours for **A Contact** automatically equal hours for **A No contact**, etc.)	8	8	8			8	8	8				
	Contact Loads					No-Contact Loads						

	Contact Loads					No-Contact Loads					Grand Totals	
Carry Forward Load Information From Previoius Sheets	Distributed Watthours Time A	Time B	Time C	Total WHRS	Total Conn Watts	Distributed Watthours Time A	Time B	Time C	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Reconfigure Loads based on when the Charger is Operating	Distributed Watthours Time A	Time B	Time C			Distributed Watthours Time A	Time B	Time C				
Loads While Charger is Operating	84,035	18,190	18,190			36,176	-	-				
Loads While Charger is NOT Operating	-	-	-			-	-	-				
	Contact Loads					No-Contact Loads					Grand Totals	
	Distributed Watthours	Charging On	Charging Off	Total WHRS	Total Conn Watts	Distributed Watthours	Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Totals to be used in Battery and Charger Sizing Design		120,415	-	120,415	16,608		36,176	-	36,176	5,369	156,591	21,977
Error Check (Green = OK)				-	-				-	-	-	-

D.7.5 Efficiencies

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL GENERAL XAI XAI

System Efficiencies and Inputs

User Entries only in Column D

Description	Eff ή %	Discussion	Default Value %					
Values Used in Battery and Charger Sizing								
Battery	80%	Eff for change from Chemical to Electrical energy. 80% to 85% for Lead Acid	80%	a				
Inverter	90%	Inverter Efficiencies peak higher but generally at full to maximum loads.	90%	b				
Charger - in Inverter / Charger	80%	The charger section is generally less efficient than the inverter section.	80%	c				
AC Wiring	97%	Assuming efficient wiring design	97%	d				
Depth of Discharge	50%		50%	e				
Days of Autonomy	1		1	f				

Description	Eff ή %	Discussion	Default Value %					
Values Used in PV Array Sizing								
Charge Controller	96%	Assume MPPT Charge Controller	95%	g				
DC Wiring	97%	Assume efficient wiring design	97%	h				
Panel Mult. Factors	92%	Includes adjustments for nameplate ratings, panel mismatch, dust.	88%	i				
Temperature Factor	85%	Ambient of 30 deg = 15%: 35 deg = 83.5%	84%	j				
System Voltage (DC)	48		48					
PSH for Design	5.5	Mozambique PSH = 5.0 to 5.5	6					
System Voltage (AC - 2Ph)	220	Mozambique = 220V; ROW - 230VAC	120					
Resulting System Efficiencies **Battery Sizing Inputs**			**Contact Loads**	**No Contact Loads**				
While Charging is in Operation								
		No load on the battery for Contact Loads	N/A					
		Charger, Inverter, AC Wiring (b,c,d,)		70%				
While Charging is NOT in Operation								
		Battery, Inverter AC Wiring (a,b,d)	70%	70%				

D.7.6 Batty-chrgr sizing

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL GENERAL XAI XAI

No Iuser Inputs on this Sheet

Battery & Charger Sizing

Values Carried over from Charging Scenarios			Contact Loads: Distributed Watthours Charging On	Contact Loads: Distributed Watthours Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts		No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Distributed Watthours Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Required AC Values at Load	AC	-	120,415	-	120,415	16,608	-	36,176	-	36,176	5,369	156,591	21,977
Adjust for Inverter and Battery	DC			-					-				
Adjust for Inverter and Charger	DC							51,798					
No Adjustment Needed	AC		120,415										
Battery Sizing			0.00%										
Total WHR Loads during no charging source	DC		-										

Values Carried over from Charging Scenarios		Contact Loads: Distributed Watthours Charging On	Contact Loads: Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts	No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
System DC Voltage	48										
Total AHR Required in Battery for the loaads during no charging source.		-									
Design Depth of Discharge	50%										
Required AHR required for one Day of Loads		-									
Days of Autonomy	1										
Required Battery Bank Size	AH	-									
Charger Sizing											
Total WHR required by No Contact Loads during Charging	DC	51,798									
System DC Voltage	48										
Required Additional AHR in Charger for No Contact Loads		1,079									
Required AHRS for Battery as Calculated above in Battery Sizing		-									
Adjust for Charger Inefficiency	80%	-									
Total AHR Requirement from Chargers	AHR	1,079									
Plus Safety Margin	1.25	1,349									
Hours of Charging	H	24									
Required Charger Amps	AMPS	56									

D.8 QUELIMANE

D.8.1 General

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name HOSPITAL QUELIMANE

General Site Information

Item	Input	Remarks
Date of Audit	29 August 2010	
Name of Auditor	Arturo Romero P	Information provided by APHL and
Affiliation of Auditor		Estefano M. by phone.
Site Coordinates		
Estimated driving time from Maputo		
Road condition		
Contact Person at Site:	Estefano Macuecua	
Phone Number of Contact Persons at Site:	258 825520309	
Title of Contact Person	Responsible in the Laboratory	
Department	Laboratory	
Type of Facility	Laboratory of the Hospital	Health Center, Hospital, etc.
Number of Patients per day	310 patience per day	
Describe Facility	it is the laboratory of the hospital	e.g. Lab, computer center, etc…
For Labs: Is this a Basic, Palliative Care, or ARV lab?		
Does this facility have a server?	yes	

Item	Input	Remarks
Operating Hours of Facility:	0700 to 1530	
Operating Days of Facility:	From Monday to Friday even some weekends too	
Are there air conditioners in use in this facility, or planned to be in use?		
Provide roof plan and photo		

D.8.2 Site power

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH
August 2010
Input Information

Facility Name HOSPITAL QUELIMANE

Site Power Supplies

Item	Input	Remarks
Grid		
Is the site connected to grid?	YES it is connected to the grid	
If YES, describe when grid is usually ON between the hours of 0700 and 1900 hrs.	24 hours	
If Yes, describe when EDM is usually ON between the hours of 1900 and 0700 hours.	24 hours	
Add any comments regarding the power availability of GRID, power quality of GRID, or any other observations.	Lab's responsible argues low quality of service due the voltaje variations and black outs	
DELCO / GENERATOR		
Is the generator for the entire facility, or dedicated to these loads?	there is a genset as a back up for the whole hospital	
Distance between generator and load center		
From Generator Nameplate:		
Manufacturer and Model No.		
Provide Data for Continuous Power Ratings:		
KVA		
KW		
Power Factor		
Voltage and Phase		
Overall Condition and age of Generator		

Item	Input	Remarks
Is it connected 1-Phase or 3-Phase		
How many hours/day does it run?		
How much fuel per hour or per day does it consume?		
Diameter of wires (feeder) to LC		
Overall wiring of the facility		
Is there a Grounding system?		
Provide Photos of Generator		

NOTES:

D.8.3 Cont & nc loads

Facility Name **HOSPITAL QUELIMANE**

Existing Loads

Area	QTY	Load	Watts Each	Contact Hrs per Day Day	Contact Hrs per Day Night	No contact Hrs per Day Day	No contact Hrs per Day Night	Contact Loads Watthours Day	Contact Loads Watthours Night	No-contact loads Watthours Day	No-contact loads Watthours Night	Watt-hours Contact Watthrs Total	Watt-hours No-Contact Watthrs Total	Watts Cont Total Conn Watts	Watts NC Total Conn Watts
	1	PENTRA 400 Biochemistry Analyser + cooler	700			6		-	-	4,200	-	-	4,200	-	700
	1	BD Facscalibur	1725			6		-	-	10,350	-	-	10,350	-	1,725
		Refrigerator- Farmacia (eurofrio)	220	4	9			-	-	-	-	-	-	-	-
		Refrigerator- Farmacia (eurofrio)	220	4	9			-	-	-	-	-	-	-	-
		Computer Dell	250			8		-	-	-	-	-	-	-	-
		Computer Dell	250			8		-	-	-	-	-	-	-	-
	1	Printer HP	75	3				225	-	-	-	225	-	75	-
		Bar code reader	35	8				-	-	-	-	-	-	-	-
	1	Printer –Bar codes / Zebra technologies	75	3				225	-	-	-	225	-	75	-
	1	Printer –DELL 1720n	550	3				1,650	-	-	-	1,650	-	550	-

Area	QTY	Load	Watts Each	Contact Hrs per Day Day	Contact Hrs per Day Night	No contact Hrs per Day Day	No contact Hrs per Day Night	Contact Loads Watthours Day	Contact Loads Watthours Night	No-contact loads Watthours Day	No-contact loads Watthours Night	Watt-hours Contact Watthrs Total	Watt-hours No-Contact Watthrs Total	Watts Cont Total Conn Watts	Watts NC Total Conn Watts
		Computer Dell	250			8		-	-	-	-	-	-	-	-
		Computer Dell	250			8		-	-	-	-	-	-	-	-
		Computer Dell	250			8		-	-	-	-	-	-	-	-
	1	BD Facscalibur	1725			6		-	-	10,350	-	-	10,350	-	1,725
		Computer Dell	250			8		-	-	-	-	-	-	-	-
	1	Printer – OKI B4350	250	3				750	-	-	-	750	-	250	-
	1	Printer DELL laser jet M5200	550	3				1,650	-	-	-	1,650	-	550	-
		Computer Dell	250			8		-	-	-	-	-	-	-	-
								-	-	-	-	-	-	-	-
Grand Totals								**4,500**	**-**	**24,900**	**-**	**4,500**	**24,900**	**1,500**	**4,150**

Total contact & no-contact WHrs	29,400
Total contact & no-contact Ahrs	612.50
Number of Strings of 8 rolls 6V 350AH Batty	1.75

D.8.4 Charging sc

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL QUELIMANE

Charging Scenarios

	Contact Loads					No-Contact Loads					Grand Totals	
Carry Forward Load Information From Previoius Sheets	Distributed Watthours			Total	Total	Distributed Watthours			Total	Total	Total	Total
	Time A	Time B	Time C	WHRS	Conn Watts	Time A	Time B	Time C	WHRS	Conn Watts	WHRS	Conn Watts
Totals for Existing Loads, Page 1	4,500	-	-	4,500	1,500	24,900	-	-	24,900	4,150	29,400	5,650
Totals for Future Loads, Page 2												
Total Load Distribution	**4,500**	**-**	**-**	**4,500**	**1,500**	**24,900**	**-**	**-**	**24,900**	**4,150**	**29,400**	**5,650**
Charger Operating Times (Hours for **A Contact** automatically equal hours for **A No contact**, etc.)	8	8	8			8	8	8				
Reconfigure Loads based on when the Charger is Operating	Contact Loads Distributed Watthours					No-Contact Loads Distributed Watthours						
	Time	Time	Time			Time	Time	Time				

	A	B	C			A	B	C				
Loads While Charger is Operating	4,500	-	-			24,900	-	-				
Loads While Charger is NOT Operating	-	-	-			-	-	-				
	Contact Loads					No-Contact Loads					Grand Totals	
		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts		Distributed Watthours Charging On	Charging Off	Total WHRS	Total Conn Watts	Total WHRS	Total Conn Watts
Totals to be used in Battery and Charger Sizing Design		4,500	-	4,500	1,500		24,900	-	24,900	4,150	29,400	5,650
Error Check (Green = OK)				-	-				-	-	-	-

D.8.5 Efficiencies

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name HOSPITAL QUELIMANE

System Efficiencies and Inputs

User Entries only in Column D

Description	Eff ή %	Discussion	Default Value %					
Values Used in Battery and Charger Sizing								
Battery	80%	Eff for change from Chemical to Electrical energy. 80% to 85% for Lead Acid	80%	a				
Inverter	90%	Inverter Efficiencies peak higher but generally at full to maximum loads.	90%	b				
Charger - in Inverter / Charger	80%	The charger section is generally less efficient than the inverter section.	80%	c				
AC Wiring	97%	Assuming efficient wiring design	97%	d				
Depth of Discharge	50%		50%	e				
Days of Autonomy	1		1	f				
Values Used in PV Array Sizing								

Charge Controller	96%	Assume MPPT Charge Controller	95%	g				
DC Wiring	97%	Assume efficient wiring design	97%	h				
Panel Mult. Factors	92%	Includes adjustments for nameplate ratings, panel mismatch, dust.	88%	i				
Temperature Factor	85%	Ambient of 30 deg = 15%: 35 deg = 83.5%	84%	j				
System Voltage (DC)	48		48					
PSH for Design	5.5	Mozambique PSH = 5.0 to 5.5	6					
System Voltage (AC - 2Ph)	220	Mozambique = 220V; ROW - 230VAC	120					
Resulting System Efficiencies **Battery Sizing Inputs**			**Contact Loads**	**No Contact Loads**				
While Charging is in Operation								
		No load on the battery for Contact Loads	N/A					
		Charger, Inverter, AC Wiring (b,c,d,)		70%				
While Charging is NOT in Operation								
		Battery, Inverter AC Wiring (a,b,d)	70%	70%				

D.8.6 Batty-chrgr sizing

Site Energy Assessments

MOZAMBIQUE

TETRA-TECH

August 2010

Input Information

Facility Name	HOSPITAL QUELIMANE
	No Iuser Inputs on this Sheet

Battery & Charger Sizing

Values Carried over from Charging Scenarios			Contact Loads: Distributed Watthours Charging On	Contact Loads: Distributed Watthours Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts		No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Distributed Watthours Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Required AC Values at Load	AC	-	4,500	-	4,500	1,500	-	24,900	-	24,900	4,150	29,400	5,650
Adjust for Inverter and Battery	DC			-					-				
Adjust for Inverter and Charger	DC							35,653					
No Adjustment Needed	AC		4,500										
Battery Sizing			**0.00%**										
Total WHR Loads during no charging source	DC		-										
System DC Voltage	48												

Values Carried over from Charging Scenarios		Contact Loads: Distributed Watthours Charging On	Contact Loads: Distributed Watthours Charging Off	Contact Loads: Total WHRS	Contact Loads: Total Conn Watts	No-Contact Loads: Distributed Watthours Charging On	No-Contact Loads: Distributed Watthours Charging Off	No-Contact Loads: Total WHRS	No-Contact Loads: Total Conn Watts	Grand Totals: Total WHRS	Grand Totals: Total Conn Watts
Total AHR Required in Battery for the loaads during no charging source.		-									
Design Depth of Discharge	50%										
Required AHR required for one Day of Loads		-									
Days of Autonomy	1										
Required Battery Bank Size	AH	-									
Charger Sizing											
Total WHR required by No Contact Loads during Charging	DC	35,653									
System DC Voltage	48										
Required Additional AHR in Charger for No Contact Loads		743									
Required AHRS for Battery as Calculated above in Battery Sizing		-									
Adjust for Charger Inefficiency	80%	-									
Total AHR Requirement from Chargers	AHR	743									
Plus Safety Margin	1.25	928									
Hours of Charging	H	24									
Required Charger Amps	AMPS	39									