Energy Audit and Green Energy Planning Report

for

One UN Headquarter Building –
Praia, Cape Verde

PROJECT: FBCVI09D01 – BL 1700

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Acknowledgement:

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1.0 Executive Summary

The Consultant has completed an energy monitoring and audit of the One UN building in Praia. The building is located at the Plateau area in the Achada district.

The cost of electricity is significantly high on the Cape Verde (CV) electricity consumers. The UN office in CV has decided identified measures for implementation to reduce operating costs.

The Consultant was engaged to analyze the operating costs in terms of electricity energy consumption, maintenance issues and appropriate technology selection at the One UN building and make the appropriate recommendations for implementation with particular attention to renewable energy (RE) systems.

It has been concluded that in order to reduce and optimize the utility billing cost at the facility, the mode of operating the facility has to change in terms of energy sources and equipment controls. The main equipment that determines the electricity load at the facility is the lighting and air conditioning systems. These loads have to be reduced and optimized in performance to reduce electricity costs. Others include changes in equipment operation and the power supply conditions.

The total estimated cost of implementation of all the recommendations is approximately US$ **96.475**. This should result in the annual electric cost reduction of US$ **22.958** and a maintenance cost saving of approximately US$ **1.600** per year.

The following measures have been recommended and analyzed for implementation.

- **Lighting Retrofits on the existing systems to reduce energy costs by approximately 35 percent**
- **Install motion sensors in office spaces to optimize lighting energy consumption**
- **Install a 25 kW Solar Photovoltaic (PV) to operate lighting and IT equipment**

Table 1 summarizes the individual energy cost reduction opportunities at the One UN Building and the total cost implication if the recommended measures are implemented.

Table 1 Details - Energy Cost Reduction Measures

Energy Cost Reduction Opportunity (ECO)	Peak Demand Saving (kVA)	Annual Energy Savings (kWh)	Annual Cost Saving USD	Annual Maintenance Cost Savings USD	Project Installation Cost USD	Simple Payback Period (years)
Install High Efficiency Lighting System	8	20,367	6,006		8,930	1.5
Lighting Energy Management System	-	7,938	2,778		3,750	1.3
Install 25-kW Solar PV System	-	40,000	14,173		82,045	5.8
Total	**8**	**68,305**	**22,958**	**-**	**94,725**	4.1

1.1.1 Other Opportunities

The following recommendation if implemented will further reduce the facility energy bills, albeit less than the major recommended cost reduction measures.

- The staff must be well educated on the need for energy conservation and cost-cutting measures.

2.0 Background and Objectives

The government of Cape Verde's (GoCV) policy to recover the full cost of energy services and products in the economy has resulted in higher energy tariffs than what most businesses have known in the past.

Moreover, the GoCV is vigorously instituting measures to reduce external dependence on costly energy sources and combat desertification. The GoCV is therefore directing the energy sector's objectives to minimize the economic cost of energy and increase the reliability of its supply. On the demand side, the GoCV is keen on increasing energy efficiency, through improvements in the power plants and distribution networks, reducing the losses of desalinated water and popularizing the use of fuel efficient woodstoves.

It is highly recommended that every business entity revisit its operating cost, in terms of electric bills for a critical assessment to determine the possibility of reducing the ever rising cost. It has become necessary for the business manager to use any possible means in the area of energy monitoring, fuel switching and energy conservation to reduce operating cost in order to remain competitive.

It is in line with these prevailing conditions, that the UN drive for promoting Green Energy and the high cost of electricity in Cape Verde that the United Nation Industrial Development Organization (UNIDO) in cooperation with the ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE) are assisting the United Nation (UN) in Praia, Cape Verde, to undertake a comprehensive energy audit of the One UN office building. The energy audit will consider various options to integrate energy efficiency and renewable energy components.

The improvements are expected to reduce the monthly electricity bill of the UN office and mitigate local pollution and greenhouse gas (GHG) emissions. It will also improve the energy security of the building and reduce the reliance on the back-up diesel generator in the case of grid failure. Moreover, the project will be an important showcase to demonstrate the benefits of renewable energy and energy efficiency to other countries in the ECOWAS region. The project will be included into the "green energy tour plan" for interested visitors and experts in the sub-Region.

The main purpose of the project is to,

1. conduct a detailed energy audit of the ONE UN Building and gain full understanding of the existing energy performance of the building, its facilities and equipment;
2. suggest various options for energy efficiency improvements, energy saving measures and the integration of on- or off-grid renewable energy components to the decision makers;
3. design and elaborate the technical specifications including the bill of quantities for the chosen measures;
4. Predict the new performance of the building with the recommended changes;

5. Develop projections of the energy performance of the building under different options;
6. Suggest measures to promote behavioral changes by the occupants to improve their energy use efficiency

The UN Headquarter building pays approximately $6.400, 00 and $760, 00 per month for electricity and water respectively. Currently there are no energy conservation measures in place to help reduce the escalating costs. The staff at their individual discretion seemingly exercises some efforts including keeping lights off and minimize the use off air conditioners to maintain lower electricity costs. The existing lighting and air conditioning technologies and operating trends are not energy efficient to minimize energy consumption.

The UN administration believes that by analyzing the current trends in energy consumption, meaningful ways could be identified to reduce the total energy costs to the administration.

It is estimated that by the use of education, technology and other appropriate measures the current total energy and operating costs could be reduced between 15 and 20 percent.

The analysis covered;

1. Monitoring and evaluation of the current power consumption at the building
2. Identify source and type of any operating problem
3. Make recommendations to eliminate or minimize occurrence of identified problems.
4. Identify the necessary measures required to reduce operating costs. These measures shall be identified and recommended for implementation with the required project implementation costs and benefits for each facility
5. Specify the quantities and types of equipment necessary to achieve cost savings

The report identifies opportunities to reduce electricity peak demand, improve power factor, and reduce electric energy consumption. Based on this information the report recommends specific measures, technologies or equipment required to obtain optimized energy cost in operating the facility.

It further specifies quantities and types of equipment required and the energy conservation potential associated with each energy conservation measure or operating cost reduction.

The report also communicates to the facility management opportunities to optimize the cost/benefit of operating expenses that could yield the following:

- *Minimized operating cost*
- *Improved leverage of facility maintenance expenses*
- *Maintain the best operating environment*

3.0 Facility Survey

The UN building is located at the Achada San Antonio section of Praia, CV.

Energy audit covered discussions with the staff on space conditions, equipment utility and occupancy schedules, taking inventory of air conditioning and lighting system equipment and maintenance issues. The audit also covered visual inspections of the structural integrity of the building. Moreover, power consumption patterns at the building was monitored with a power analyzer for a week's period to determine the pattern of power consumption in terms of voltage, current, power factor, demand, consumption, etc.

The exercise has offered an extensive opportunity to learn of operating issues pertaining to preference, environmental conditions and operating difficulties.

The survey was conducted with operating personnel of the UN building. The contractors for lighting and air conditioning systems were consulted to ascertain the existing system layout.

3.1.1 General Overview

The building is a 4-storey with a partial fifth floor. It runs in length from East to West and the main entrance faces south. The building is constructed to enclose an open-air atrium.

The ground floor is essentially the Reception, a Clinic, the old West African Institute office, a Library and a car parking garage.
The next three storeys are similar in the sense that they are all office spaces with at least four washrooms spread out at the ends of each floor.

The construction is of cinder block masonry with single-glazed, steel-framed windows. The outside walls is painted with the UN blue and sectioned with 50 percent windows with blue venetian blinds. The internal walls are solid vinyl partitions with single transparent glazing. The roofing is made up of concrete masonry

Occupancy schedules of the building range from 24-hour guard duty by security to an average 10-hour office working hours on weekdays. Weekend occupancy is relatively light compared to business days.

Lighting and air conditioning use is consistently high throughout the week at the design weather conditions. There is minimal use of air conditioning in January and February months. Space temperature set points are at 24 °C on average.

3.1.2 Operating Systems

Cooling Systems: Air conditioning (A/C) is provided to all building spaces with 91 split systems. They are predominantly LG split systems. Please see equipment inventory in the Appendix I.

The condensing sections are located outside on steel fabricated mounting brackets on the outside walls hidden from view by the concrete facia walls. The evaporating or cooling sections are wall-mounted in the controlled space.

Cooling conditions in the occupied space is controlled with a wireless controllers handled by the occupant.

The maintenance of the cooling system has contracted out to a local company in CV. All maintenance issues are referred to the contractor. The contractor is scheduled to perform routine filter cleanup, gas recharging and others on a quarterly basis throughout the year. Material for maintenance is supplied by the UN as needed.

Lighting: Lighting fixtures at the building is predominantly fluorescent. It is either the 11-watt Compact Fluorescent Lamp (CFLs) in the hallways and 2X2-foot fixture with four 18-watt lamps or the 4-foot fixtures with two 36-watt lamps. They are all surface-mounted and have egg-crate diffusers. There are a few high intensity discharge (HID), 400-Watt mercury vapour light fixtures mounted along the security fence and the parking lot.

The interior fixture types are,

- four (4)-foot surface-mounted with two 36-watt lamp and egg-crate diffusers,
- two (2)-foot surface-mounted fixture with four 18-watt lamps and egg-crate diffusers
- a few single or two 36-watt surface-mounted waterproof, dustproof fixtures
- Surface-mounted 7 and 11-watt CFLs mainly found in the hallways

The exterior lighting fixture types are,

A few are HID fixtures with 400-watt mercury vapor and pole-mounted 18-watt CFLs.

The fluorescent lamp types in the office spaces are mainly T12 4100K (cool white) with a few 3500K (warm white) systems. All the fluorescent lights are powered with magnetic ballasts.

Potable Water: Water is metered by the Electra Company at the take-off point into the compound. There is an underground hold tank from where the water is pumped up to storage tank located at the fourth floor storage room.

There are four 1000-litre potable storage tanks located on the fourth floor. Water is then pumped down to all sections of the building with two (2) booster pumps.

Standby Power Supply: A much older but well kept 330 kVA power generator is used for standby power supply. Upon power interruption from the utility company the standby diesel generator is switched on automatically after a short period. The generator unit was manufactured in 1991. The power generation section is a 2000 Series Perkins unit rated at 325 kVA with 0.8 power factor. The unit seems well maintained.

The system supports the entire UN building and a lone house of one of the UN staff whose resident is elsewhere in the neighborhood.

3.1.3 General Observations

The building is generally in good and well-maintained condition. It is well secured as necessary to meet the UN requirements.

The close proximity to the sea has taken its toll on the building structure. The strength of the concrete masonry is affected in several areas in the roof parapet and the fence walls. This may be due to the rust of the enclosed iron rod supports in the construction of the building.

Sections of the wall parapets up on the roof have been compromised that any slight ground movement will dislocate all these sections. This shall be dangerous to passer-bys below.

In addition it seems as a habit of the occupants to leave some upstairs doors wide open to allow untreated outside breeze into the building for comfort. This behaviour exposes the indoor air quality which adversely affects office equipment operation.

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4.0 Utility Rate Structure Analysis

4.1.1 Electricity

The facility is charged for electricity billing based on the BTE load tariff, low voltage (SLT-LV) through the use of a credit meter from the Electra utility company.
The electricity bill is composed of (1) a customer charge, and (2) energy rate charge and applicable levies and taxes.

A breakdown of the current Electra BTE rate structure is as follows:

BTE:

Customer Charge:	45,594 ECV or $541.95 per month
Energy Charges:	24.81 ECV or $0.29/kWh

Other factors affect the actual charges reflected on the utility bill. These include Government Levy, Power Factor (PF) effects and Value Added Tax (VAT).

There is neither demand nor power factor surcharges on the account.

4.1.2 Water

Water is supplied to the facility by the Electra Company as well. The supply is billed through the Commercial Service Water tariff structure. The supply is metered and pumped with booster pumps to storage tanks located on the fourth floor. Two other distribution pumps distribute water from the tanks to points-of-use throughout the building.

The unit cubic meter is charged at **475.53 ECV** or **$5.65**. In addition the customer is assessed a 15 percent.

4.1.3 Meter Analysis

The meter has been analysed in this predominant use study. The energy consumption of the meter has been broken up to reflect the approximate (within 10% of actual) end-use by lighting, air conditioning and other miscellaneous equipment. Miscellaneous items include regular office equipment. See Table-3
The cost allocation does not reflect taxes and other incidental charges.

4.1.4 Table 3 Electric End Use Breakdown

The end-use breakdown of power consumption has been analyzed with the following;

- None of the air conditioning units was operational over the duration of the power monitoring. The power consumption in the building was mainly due to lighting load and office equipment power consumption.

- The overnight power load could be attributed to mainly the outside lighting and some office equipment (eg. data maintenance, server room) in operation.

- Peak air conditioning loads during extreme outside conditions have been estimated from nameplate date secured from the building

System/Area	Peak Demand (kVA)	Equivalent Full Load Hours	Energy Consumption (kWh)	Electric Costs (ECV)	Electric Costs (US$)	Percent Cost (%)
Air Conditioning	65	4,000	143,780	3,567,182	42,401	61%
Lighting	24	3,000	61,881	1,535,264	18,249	26%
Misc Equipment	13	3,000	31,200	774,072	9,201	13%
Total	**102**		**236,861**	**5,876,518**	**69,850**	**100%**

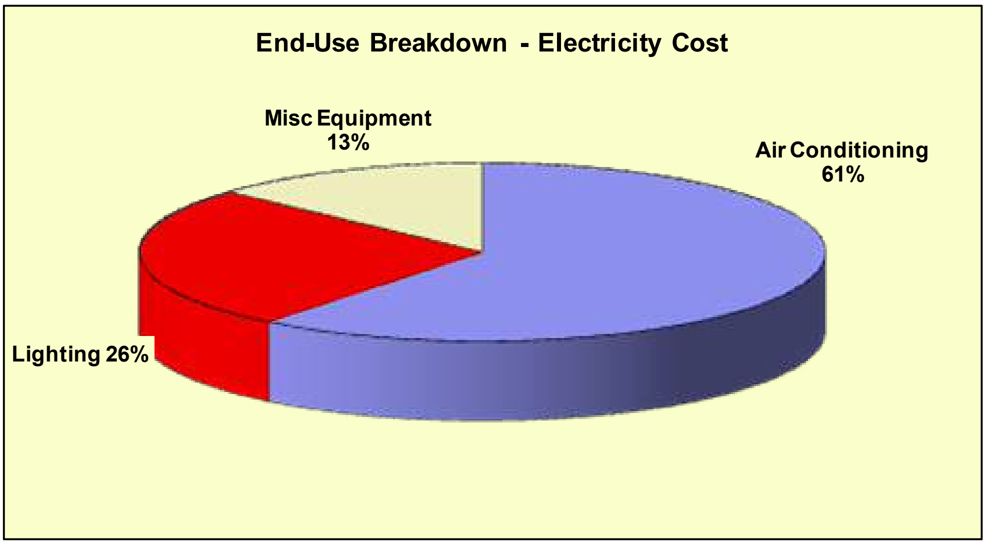


Figure 1a End-Use Breakdown - Electricity Cost

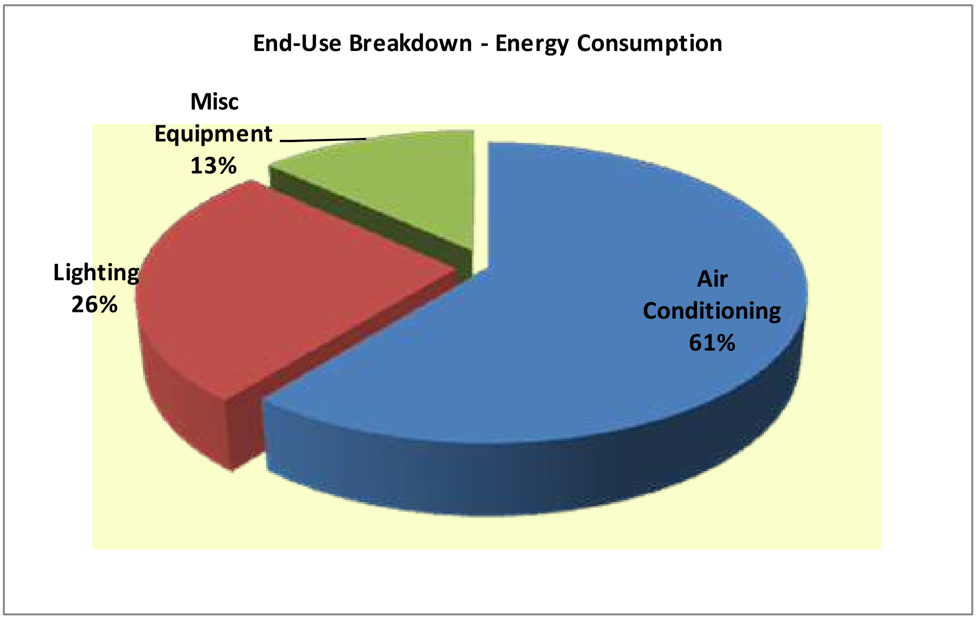


Figure 1b End-Use Breakdown - Energy Consumption (kWh)

5.0 Facility Energy Consumption

5.1.1 Utility Supply and Billing History

Electricity is supplied to the UN building from Electra through a 500 kVA packaged transformer located away from the property. Power is directed into power house located at the northeast corner of the property. The distribution panel separates supplied power to an adjacent power separation building. From a buss bar power is tapped off to various sections of the complex.

Table 5.1 and Table 5.2 below show the 2011 electric and water billing history.

Table 5.1 2011 Electricity Billing History

Month	Energy (kWh)	kVAh	Energy Charge (ECV)	Service & Tax Charges (ECV)	Monthly Cost (ECV)	Monthly Cost (US$)
Dec	17,940	5,520	445,091	68,907	513,998	6,110
Jan	20,280	5,880	503,147	70,754	573,901	6,822
Feb	11,453	3,600	284,149	64,847	348,996	4,148
Mar	13,358	3,360	331,412	63,031	394,443	4,688
April	20,003	5,760	549,889	74,775	624,664	7,425
May	14,873	3,960	439,348	69,401	508,749	6,047
June	16,305	4,440	481,650	69,792	551,442	6,555
July	17,265	4,320	510,008	71,068	581,076	6,907
Aug	32,370	8,760	624,771	76,232	701,003	8,332
Sept	21,308	6,120	629,438	76,442	705,880	8,390
Oct	24,270	6,960	716,936	80,380	797,316	9,477
Nov	22,568	7,080	666,659	78,117	744,776	8,853
Total	**231,990**	**65,760**	**6,182,498**	**863,746**	**7,046,244**	**$ 83,754**

In addition to the electricity supply a standby Generator or Genset is used as a backup unit to the Electra power supply service. The unit is a 330 kVA Perkins unit.

Upon power failure from the utility company the Genset is automatically switched on to supply power to the entire building. The switchover control system is located in the Electric panel housing.

A single BTE tariff credit meter is used by the utility company to bill the building on a monthly basis.

Table 5.2 2011 Metered Water Billing

Month	Metered Volume (M^3)	Water Charge (ECV)	Service & Tax Charges (ECV)	Monthly Cost (ECV)	Monthly Cost (US$)
Dec	121	57,657	1,728	59,385	706
Jan	197	93,719	2,812	96,531	1,147
Feb	157	75,161	2,241	77,402	920
Mar	147	69,951	2,099	72,050	856
April	109	54,487	1,622	56,109	667
May	113	57,062	1,704	58,766	699
June	100	50,262	1,508	51,770	615
July	134	67,326	2,020	69,346	824
Aug	109	54,779	1,643	56,422	671
Sept	109	54,779	1,643	56,422	671
Oct	128	64,314	1,929	66,243	787
Nov	107	53,775	1,613	55,388	658
Total		**753,272**	**22,562**	**775,834**	**$ 9,222**

5.1.2 Monitored Electricity Utility

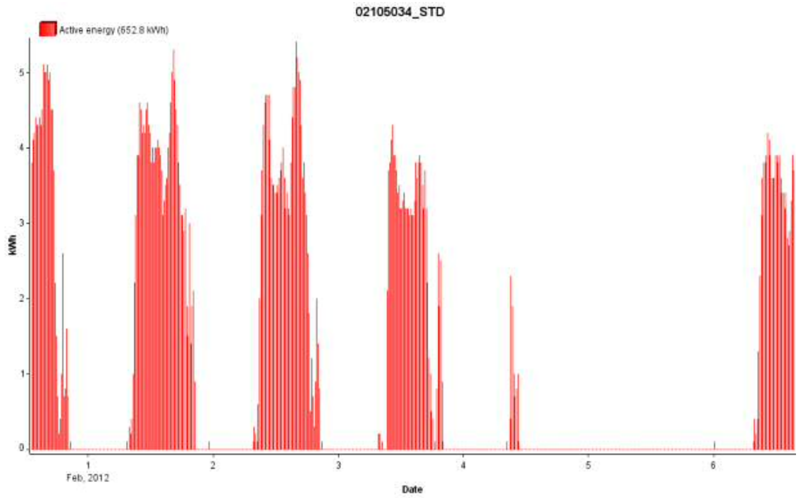
The electricity billing data over the past year (2011) was simulated with the installation of a power analyzer for nearly a one week period. The demand (kVA) and energy (kWh) consumption pattern retrieved from the analyzer is shown in Chart 5.2 below.

The power consumption monitoring of the facility was performed and matched with billing data from the utility company to ascertain accuracy in billing and to determine the correct tariff category appropriate for the facility. Moreover, it helped determine the end-user breakdown of power consumption in the building.

The recorded information could not be used to match the billed power consumption of the building. This is due to the fact almost all the air conditioning units were off over the week of monitoring the building energy consumption. The early February weather was unusually cool for the Praia area. The simulated annual energy consumption is therefore found to far less than the metered information from Electra for the previous year.

Nevertheless, the best means to reduce the current charges is to identify ways to reduce energy (kWh) consumption through energy conservation and efficient equipment use.

Chart 5.1: One UN Building - Monitored Daily Electricity Consumption



The above chart indicates an average daily peak load of 123 kVA during regular business hours. The high or peak points show the extent of a weekday's occupancy loads. There is an occurrence on Saturday which seems like occupancy for a short period.

This reflects no air conditioning load over the monitored period. It is estimated that the use of air conditioning may double the recorded power consumption.

The monitored energy consumption was approximately 700 kWh for the duration of monitoring.

6.0 Conclusions & Recommendations

General

The analysis of the power consumption and use patterns shows that the all electric equipment of the facility contributes to the operating costs. Electricity prices have been rising steadily over the last couple of years.

All operating equipment in the building must be energy efficient and controlled efficiently to optimize the energy consumption level at the complex.

This decision will require a significant equipment replacement but the economics should be considered for justification. These recommendations if implemented should reduce the peak demand of the facility and operating hours of equipment use and thereby reduce the total operating cost.

Lighting Systems

The lighting system at the UN building is not efficient in terms of energy consumption. The existing lighting systems should be replaced with similar fluorescent fittings with T5 lamps and electronic ballasts, while the aesthetics of the existing lighting system is maintained. These changes will reduce the lighting energy consumption by approximately 35 percent.

In addition, the lighting system must be controlled for best performance. Installation of occupancy sensors is recommended to remove operating sequence from manual to automatic controls. The sensors monitor specific areas and automatically turn lights ON when occupancy is detected. When the area is no longer occupied, the sensors automatically switch the lights OFF after a user-selected time interval.

Lighting typically accounts for 30 – 40 percent of an office building's energy bill, yet many offices and other areas are unoccupied for a significant part of the day. The lighting systems at the may be ON up to 12 hours daily in some areas. In some cases the lights could be turned off for periods when the space is unoccupied to reduce energy consumption. This must be done automatically with Occupancy Sensors. Typical sensor operating benefits are shown in the table below:

Occupied Area	Maximum Reduction in Energy Consumption with Occupancy Sensors
Private Offices	15-50%
Common Office Area	15-40%
Classroom	40-46%
Conference Room	22-65%
Rest Rooms	30-90%
Corridors	30-80%
Storage Areas	45-80%

Sample Occupancy Sensors

Ceiling-mounted unit

Wall-mounted unit

Air Conditioning Systems

Most of the air conditioning systems are not new. Moreover, their operation determines a significant portion of the building's energy consumption. Timer controls should be installed for a reduction in A/C operating hours. This measure will result in approximately 15 percent energy cost reduction from the current level of A/C energy consumption.

Staff Education

The operating personnel, especially the custodians should be educated as to the cost of their actions vis-à-vis equipment operation and its consequences on the operating costs of the facility. The human attention required to help optimize energy consumption is usually absent in controlling operations of this nature. Automation of most of the operations must be critically considered for the best results to optimize energy consumption.

7.0 ENERGY COST REDUCTION OPPORTUNITIES & DETAILS

Through our observation, analysis and interviews, the following cost reduction improvement opportunities have been identified.

1. The One UN Building should consider the conversion of all lighting systems at the Chancery to the T5 high efficient units to reduce the current lighting energy use by approximately 35 percent.

2. Install occupancy sensors for optimized lighting energy consumption.

3. Install a hybrid Solar PV system on the roof of the building. The system is to be designed to provide power for the entire lighting and the office equipment systems. Any surplus power will be sold to the municipal grid. The proposed solar system should reduce the operating cost for electricity significantly.

7.1.1 COST REDUCTION AND IMPROVEMENTS DETAILS

7.1.2 LIGHTING RETROFITS

Existing System:

The lighting systems in the UN building are predominantly fluorescent fixtures in the interior spaces, and partly fluorescent and HID fixtures for external use.

The interior lighting fixtures are four-foot, 2-lamp, 40-Watt or two-by-two-foot, 4-lamp 18-Watt troffer fixtures. The lamp output is a mixture of warm white (3500K) and cool white (4100K) through plastic parabolic lens. The light fixtures are fitted with energy inefficient magnetic ballasts.

There are also compact fluorescent light (CFL) fixtures which are found in the hallways, reception and restrooms. The CFLs are efficient in energy consumption.

Outside lighting is provided with a combination of 400-Watt stud-mounted mercury vapour and pole-mounted 18-Watt CFLs lighting systems. All the outside lights are controlled with photo-sensor units.

Proposed System:

1. Replace the existing fluorescent lighting systems with comparable units with electronic ballasts and T5 lamps. The T5 lamp draws 28-Watts of power per lamp compared with 40-Watts per lamp in the existing system.

   Thus with the replacement system, the energy consumption of each fixture is reduced by as much as 35 percent of current energy use.

   This measure involves complete replacements of lighting existing troffer with new IP-55 rated units. At minimum, the current lighting output shall be maintained in both interior and outside locations. Detailed analysis of the cost savings is shown in Appendix II

2. Replace the 400-Watt mercury vapour fixtures with 250-Watt metal halide fixtures.

Fig 7.1 - Existing Lighting System – F40T12

Fig 7.2 – Proposed Lighting System – F28T5

7.1.3 INSTALL LIGHTING MANAGEMENT SYSTEMS

Existing System:

The existing lighting systems are manually operated by the occupants. Therefore lighting may be on continuously until the custodians are leaving the building after clean up hours. Individual offices and private spaces have isolated single or double wall switches.

The present system without planned sequence of lighting utility sustains a significant energy waste. This should be streamlined with proper control technologies.

Proposed System:

It is recommended that occupancy sensors be installed in all the lighting circuitry as necessary to curtail energy waste. This will minimize and prevent inadvertent lighting power consumption. Individual offices will have the existing lighting switch adapted with wall-mounted occupancy sensors, while lighting in the common opened office spaces will be controlled with ceiling-mounted sensors. The lighting sensors shall have dual technology (infrared and ultrasonic) specifications for the required versatility.

The ceiling-mounted (just like the existing smoke detectors) sensors will be tied into the existing lighting circuitry in a matrix to provide complete coverage of the floor spaces. The lighting switches will be left in the ‘on’ position for the sensors to control lighting energy based on occupancy and timed ‘off’ setup.

In this system areas are only lit based on actual occupancy or detected motion, thereby preventing lighting energy waste while serving the dual purpose of energy conservation and security alert.

7.1.4 INSTALLATION OF A SOLAR PHOTOVOLTAIC (PV) SYSTEM

Existing System

The current power shortages in Praia affect the operation of the building. There is adequate power back-up provided with a 330 kVA generator but the unit uses diesel which has greenhouse gas effects.
Moreover, the unit cost of electric power is high due to the lack of options for the utility company on the island.

Proposed System

Install a new grid-connected Solar Photo Voltaic (PV) system with batteries, inverter, etc to harness the sun energy to provide a 25 kW generation. The system shall be designed to support the entire lighting and other systems in the building except the air conditioning units.

The system shall be designed and controlled to provide power on to the ELECTRA-owned power grid for sale. The terms of the relationship with ELECTRA shall be negotiated before installation goes ahead.

In addition to integration with the UN Building energy usage, the solar system will serve to demonstrate how distributed renewable energy resources may be connected to the grid while reducing energy costs of participating customers.

Decentralizing the grid is an undertaking and strategic opportunity that will benefit the UN building and the utility company in Praia. This project at the UN Building will have a significant impact on how renewable energy sources can be used and managed in the future for the world organization in Africa if not the whole world. It is a project that will help find new ways to utilize clean, renewable energy resources to reduce operating costs at the UN organization.

The 25-kW rooftop solar PV system is estimated to generate around 50,000 kWh of energy, annually, for the building. The entire solar system consists of 252 photovoltaic (PV) modules and one solar inverter. The solar inverters transition the direct current (DC) to alternating current (AC) for immediate use throughout the building. In addition, the installation incorporates a monitoring system to feed real-time energy generation data to the UN/ECREEE and ELECTRA personnel. The system shall have a life expectancy of approximately 25 years.

Besides cost savings, other benefits of PV systems include greater energy independence and a reduction in fossil fuel use and air pollution.

Assumptions

- Achievable 2,000 hours/year of lighting peak power supply
- 75 percent load factor
- Continuous power supply

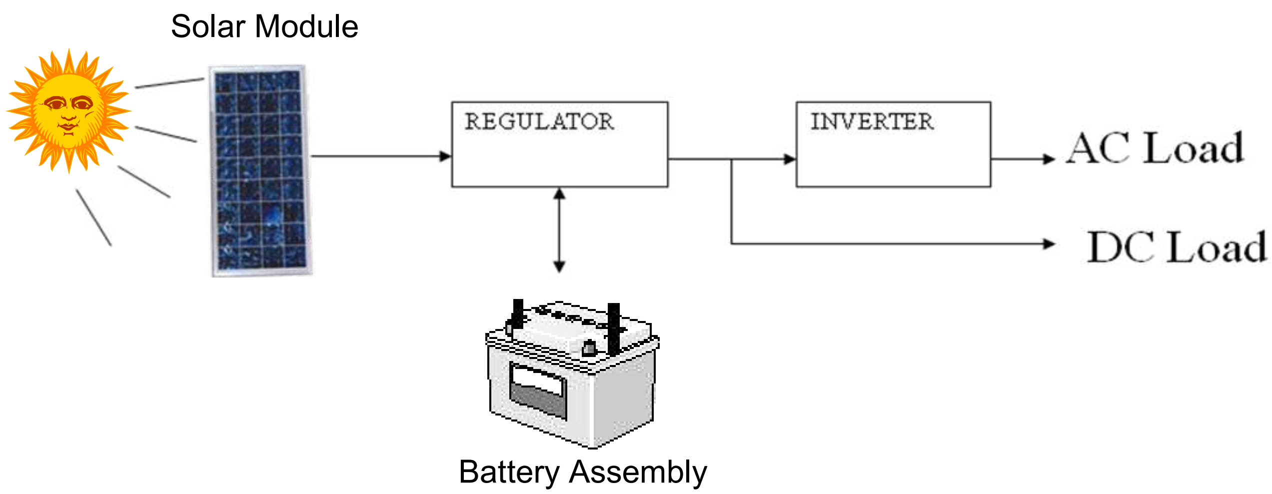


Fig 7, 1, 5 Solar PV System Schematic

8.0 APPENDIX

9.0 Appendix 1: Power Measurements

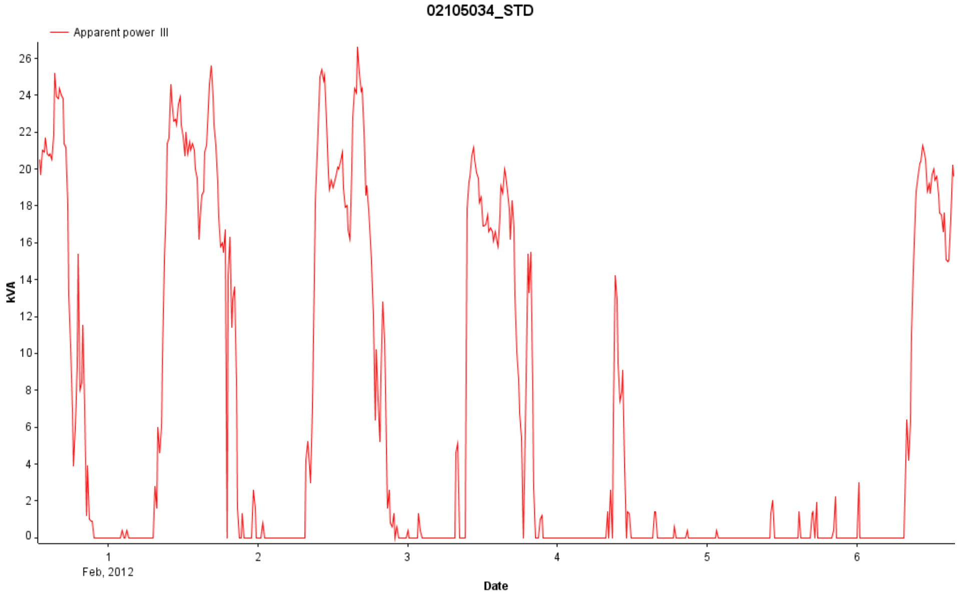
9.1.1 General

The daily load curves as measured are shown in Charts 1 through 4 for the UN Building. These have been measured to help track changes in power consumption during normal operations. It is also to help explain the energy cost reduction recommendations presented in the report.
The period covered was unusually cool in Praia. Almost all the air conditioning systems were off. Space temperatures were recorded in the range of 23 to 26 °C. In addition

Daily Load Curves

The electricity consumption of the building was measured over a 1-week period from Tuesday, January 31 to Monday, February 7, 2012 inclusive. Measurements were taken on the main power supply located at the main power supply point at the power house.

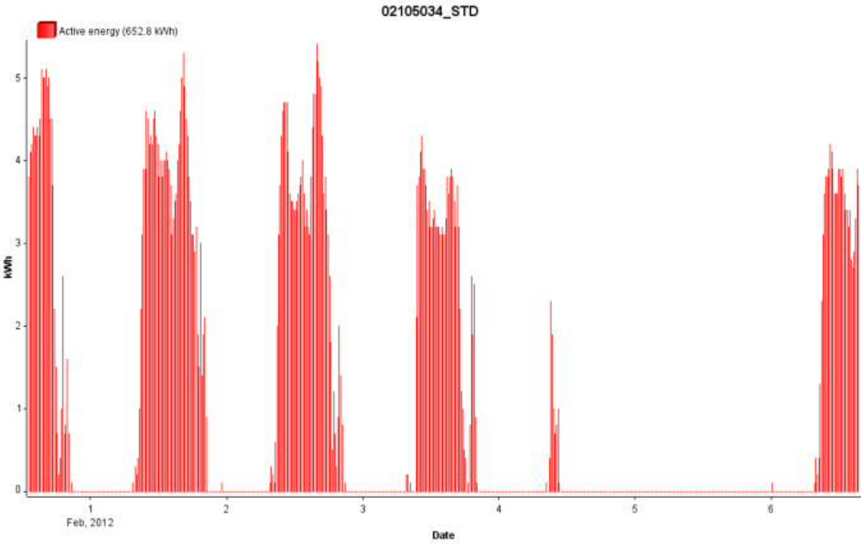
9.1.1.1 Daily (One Week) Power Utility Trend



The peak power trend shows approximately 30 kVA increase in power consumption from off-peak to peak level during business hours during the monitoring period. There is intermittent power consumption over the weekend. It is to be noted that the recorded peak power is not the actual case since equipment like the 91 split air conditioning units and approximately 50 percent of the lighting units were off over the monitoring period. It is estimated that at real peak power consumption level is two and half times the recorded figures.

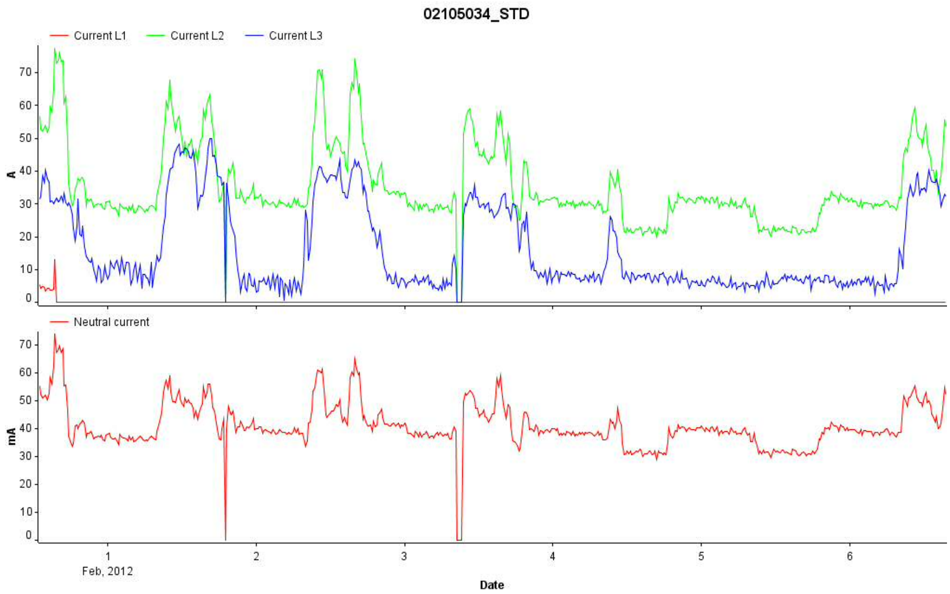
The spikes on the weekend period indicate minimal activities on those days.

9.1.1.2 Energy (kWh) Consumption



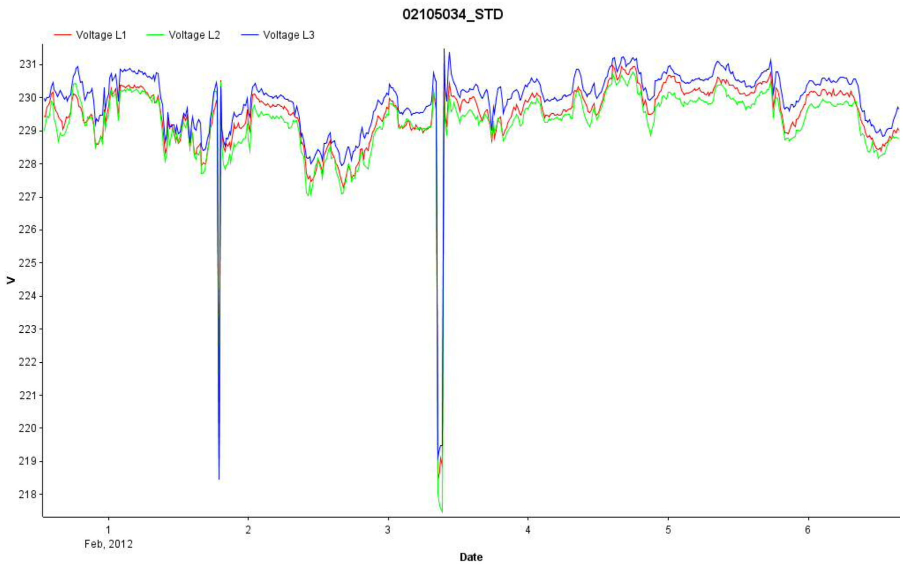
Energy consumption increases consistently from virtually no value to peak conditionings daily during the week. The trend shows that night time power usage is not existent. There is only power consumption for outside lighting and a few equipment such as the elevator and IT equipment. The total recorded energy of 653 kWh over the monitored period. In real terms the figure would definitely be twice as much when the air conditioning units are in operation.

9.1.1.3 Current (Amp) Fluctuation



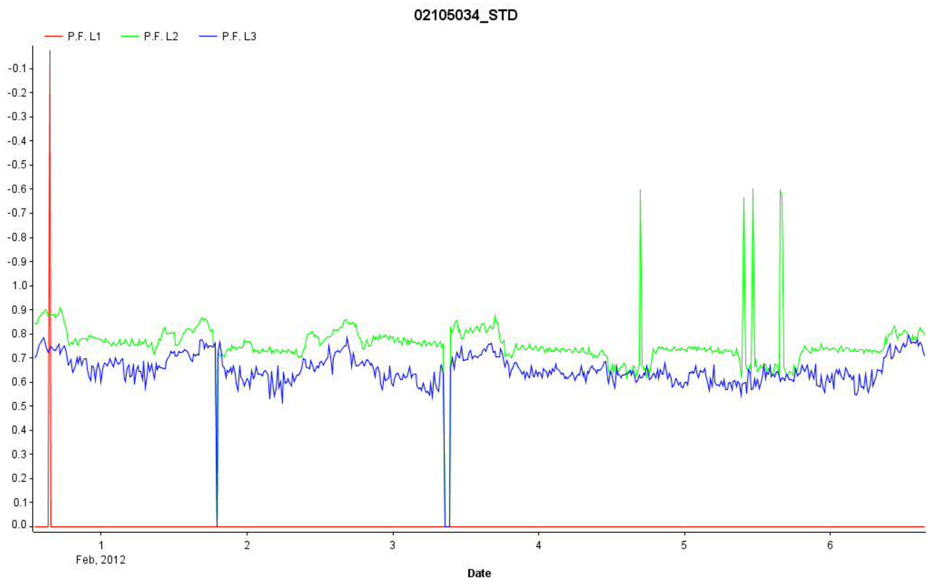
The chart shows that in the current (A) trends, one of the 3 phases over the monitored period. It indicates that Phase-1 is very inactive in the building power system over the monitored period. It is our suspicion that the Phase-1 handles mainly the air conditioning systems. There seems to be almost no current leakage since the values in the neutral line is minimal.

9.1.1.4 Daily Voltage Fluctuation



The voltage levels fluctuate between 227 and 231 Volts during the business days. This indicates a relatively stable power system. The lower levels are attained during the peak period changing to the high level during the night off-peak. During weekend period the voltage level reaches a high of 230 volts. The voltage swing levels seem acceptable but high levels of fluctuations tend to adversely affect equipment operation.

9.1.1.5 Power Factor Fluctuation



This factor is monitored to indicate the overall efficiency of the facility's power system. The utility company expects a high efficient system at the customer's point of service. The power factor is recorded at 80 percent on average... Again this is not a true picture of the system since the air conditioning systems were offline at the period of monitoring. It is showing here yet still that Phase-1 is virtually off. This reinforces our deduction that most of the air conditioning units are on Phase-1 circuit.

Installed Power Analyzer at the Power Monitoring Period

System Control Module of the Standby Power Generator

Water Supply Metering Chamber

10.0 Appendix II: Equipment Data

10.1.1 UN Building Equipment Data – Air Conditioning Systems

Unit #	Room #	Area	Manufacturer	Mod #	Refrigerant		Full Load Amp	Estimated kW/Unit	Estimated kWh/yr
Gnd Floor									
1	**Sala Nº 76**	PBX -ROOM	KENIC	KFR - 26	R-407	Bom	7.5	0.94	1,406
2	**Sala Nº 77**	CANTINA	L G	KS-	R-22	Razoavel	9.1	1.14	1,706
3	**Sala N º 78**	CENTRO DOCUM.	FNAC	KF - 180	R-22	Razoavel	13.6	1.70	2,550
4	**Sala N º 78**	CENTRO DOCUM.	FNAC	KF - 180	R-22	Razoavel	13.5	1.69	2,531
5	**Sala Nº 72**	Dr. CURSINO	LG	S 186 DP	R-22	Razoavel	8.4	1.05	1,575
6	**Sala Nº73**	ADMIN.ASSIST	LG	S 126 DP	R-22	Razoavel	7.1	0.89	1,331
7	**Sala Nº74**	REUNIÃO	WestPoint	WSZ 12	R-22	Razoavel	7.3	0.91	1,369
8	**Sala Nº 1**	ENFERERMEIRA	FNAC	KF 180	R-22	Razoavel	12.9	1.61	2,419
9	**Sala Nº2**	DOUTORA	FNAC	KF 180	R-22	Razoavel	13.5	1.69	2,531
10	**Sala Nº3**	SALA D´ESPERA	FNAC	KF 180	R-22	Razoavel	13.5	1.69	2,531
11	**Sala Nº4**	LABORATORIO	FNAC		R-22	Razoavel	9.5	1.19	1,781
12	**Sala Nº4**	LABORATORIO	FNAC		R-22	Razoavel	9.6	1.20	1,800
1st Floor									
13	**Sala Nº300**	RECEPÇAO	Westpoint	WSM09	R-22	Razoavel	6.2	0.78	1,163
14	**Sala Nº301**	REPRESENTANTE	Kenic	KFR-50GW	R-407	BOM	8.5	1.06	1,594
15	**Sala Nº302**	ASSIST.ADMIN	Alasca	SAC 3510	R-410	BOM	7.2	0.90	1,350
16	**Sala Nº303**	SEC.REPRESENT	Westpoint	WSM09	R-22	Razoavel	6.4	0.80	1,200
17	**Sala Nº304**	ASSIST. INFORM	Kenic	KFR-26GW	R-407	BOM	8.6	1.08	1,613
18	**Sala Nº305**	BIBLIOTECA	Fora de	-	-	-	-	-	-
19	**Sala Nº306**	EPIDEMIOLOGIA	Alasca	SAC 3510	R-410	BOM	7.3	0.91	1,369
20	**Sala Nº307**	SERVIDOR	YOKO	ADR-9001.5	R-407	BOM	6.5	0.81	1,219
21	**Sala Nº308**	SALA REUNIAO	Westpoint	WSG12	R-410	BOM	7.4	0.93	1,388
22	**Sala Nº309**	ADMINISTRADOR	Alasca	SAC 3510	R-410	BOM	7.4	0.93	1,388
23	**Sala Nº62**	SALA REUNIAO	**LG**	HS-	R-22	Razoavel	8.3	1.04	1,556
24	**Sala Nº63**	SECRETARIA REP	**LG**	HS-	R-22	Razoavel	8.2	1.03	1,538
25	**Sala Nº64**	REPRESENTANTE	**LG**	HS-	R-22	Razoavel	8.2	1.03	1,538
26	**Sala Nº65**	PROGRAMA	**LG**	HS-	R-22	Razoavel	8.2	1.03	1,538
27	**Sala Nº66**	ADMINISTRAÇAO	**LG**	HS-	R-22	Razoavel	7.5	0.94	1,406
28	**Sala Nº67**	OPERAÇOES/ADM	**LG**	HS-	R-22	Razoavel	7.5	0.94	1,406
29	**Sala N68**	INFORMAÇAO R.C	**LG**	HS-	R-22	Razoavel	7.6	0.95	1,425
30	**Sala Nº69**	SERVEUR	**LG**	HS-	R-22	Razoavel	7.5	0.94	1,406
31	**Sala Nº70**	BIBLIOTECA	**LG**	HS-	R-22	Razoavel	7.5	0.94	1,406
32	**Sala Nº06**	CONSULTANTS	**LG**	HS-	R-22	Razoavel	7.3	0.91	1,369

A/C System Inventory cont'd

2nd Floor									
33	**Sala Nº31**	CHEFE AMBIENTE	LG	HS-	*R-22*	BOM	8.3	1.04	1,556
34	**Sala Nº32**	REP. ADJUNTA	LG	HS-	*R-22*	BOM	8.2	1.03	1,538
35	**Sala Nº33**	ASSIST.REPRESENTA	Westpoint	WSG12	*R-410*	BOM	7.3	0.91	1,369
36	**Sala Nº34**	REPRESENTANTE	Westpoint	WSG12	*R-410*	BOM	7.3	0.91	1,369
37	**Sala Nº35**	SALA FOTOCOPIA	SONIC	AUS-	*R-22*	MAU	6.8	0.85	1,275
38	**Sala Nº36**	CONSULTOR	FNAC	KF 125	*R-22*	MAU	7.4	0.93	1,388
39	**Sala Nº37**	ASSIST.AMBIENTE	FNAC	KF 125	*R-22*	MAU	7.5	0.94	1,406
40	**Sala Nº38**	CHEFE U.COERENCIA	FNAC	KF 125	*R-22*	MAU	7.5	0.94	1,406
41	**Sala Nº39**	ASSIST. REP ADJUNTA	SONIC	AUS-	*R-22*	Razoavel	6.5	0.81	1,219
42	**Sala Nº40**	CONSULTOR	FNAC	KF 125	*R-22*	MAU	7.4	0.93	1,388
43	**Sala Nº41**	CHEFE U. POBREZA	Westpoint	WSG12	*R-22*	Razoavel	7.4	0.93	1,388
44	**Sala Nº42**	ASSIST. POBREZA	FNAC	KF 125	*R-22*	MAU	7.5	0.94	1,406
45	**Sala Nº43**	UNV	FNAC	KF 125	*R-22*	BOM	7.4	0.93	1,388
46	**Sala Nº45**	SALA DE REUNIAO	LG	HS-	*R-22*	BOM	8.3	1.04	1,556
47	**Sala Nº45**	SALA DE REUNIAO	LG	HS-	*R-22*	BOM	8.3	1.04	1,556
48	**Sala Nº46**	VERA	FNAC	KF 125	*R-22*	Razoavel	7.5	0.94	1,406
49	**Sala Nº47**	COMPAS	FNAC	KF 125	*R-22*	Razoavel	7.4	0.93	1,388
50	**Sala Nº48**	VACANT	LG	HS-	*R-22*	Razoavel	6.9	0.86	1,294
51	**Sala Nº49**	VACANT	LG	HS-	*R-22*	Razoavel	6.8	0.85	1,275
52	**Sala Nº50**	SANDRA	SONIC	AUS-	*R-22*	Razoavel	6.5	0.81	1,219
53	**Sala Nº52**	UNIFEM	LG	HS-	*R-22*	Razoavel	6.4	0.80	1,200
54	**Sala Nº53**	EDUARDO CARDOSO	LG	HS-	*R-22*	Razoavel	6.5	0.81	1,219
55	**Sala Nº54**	PAULA MAXIMIANO	LG	HS-	*R-22*	Razoavel	7.3	0.91	1,369
56	**Sala Nº55**	CHEFE C.HUMANO	LG	HS-	*R-22*	Razoavel	7.5	0.94	1,406
57	**Sala Nº56**	ASSIST.C.HUMANO	LG	HS-	*R-22*	BOM	6.3	0.79	1,181
58	**Sala Nº57**	SERVER	LG	HS-	*R-22*	BOM	6.3	0.79	1,181
59	**Sala Nº58**	CHEFE.B.GOVERNANÇ	FNAC	KF 125	*R-22* √√	MAU	7.4	0.93	1,388
60	**Sala Nº59**	ASSIST.B.GOVERN	LG	S 126 DP	*R-22*	BOM	7.4	0.93	1,388
61	**Sala Nº61**	CARLOS BRITO	LG	S 126 DP	*R-22*	BOM	7.4	0.93	1,388
62	**Sala Nº1**	CONSULTOR	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
63	**Sala Nº2**	NAC. OFFICER	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
64	**Sala Nº3**	COORDENADORA	FNAC	CU 180	*R-22*	MAU	8.3	1.04	1,556
65	**Sala Nº4**	ASSIST.ADMIN FIN	SONIC	AUS-	*R-22*	MAU	7.6	0.95	1,425

A/C System Inventory cont'd

3rd Floor									
66	**Sala Nº1**	VACANT	Westpoint	WSG12	*R-410*	BOM	8.3	1.04	1,556
67	**Sala Nº2**	ALZIRA CABRAL	LG	HS-	*R-22*	BOM	8.2	1.03	1,538
68	**Sala Nº3**	HR ASSOCIATE	LG	HS-	*R-22*	BOM	7.3	0.91	1,369
69	**Sala Nº4**	PROCUREMENT	LG	HS-	*R-22*	BOM	7.3	0.91	1,369
70	**Sala Nº5**	HR. ASSCIATE	LG	HS-	*R-22*	BOM	6.8	0.85	1,275
71	**Sala Nº6**	ADMIN.ANALYST	LG	HS-	*R-22*	BOM	7.4	0.93	1,388
72	**Sala N7**	OPER. MANAGER	SHARP	AH-A244E	*R-22*	MAU	7.5	0.94	1,406
73	**Sala Nº9**	REPROD. ROOM	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
74	**Sala Nº10**	ADMIN.ASSIST	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
75	**Sala Nº11**	TRAVEL ASSIST	LG	HS-	*R-22*	BOM	7.4	0.93	1,388
76	**Sala Nº12**	UNV. MAZA	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
77	**Sala Nº13**	DRIVER´S ROOM	Westpoint	WSG12	*R-410*	BOM	7.5	0.94	1,406
78	**Sala Nº16**	VACANT	FNAC	PRECMO2F	*R-22*	Razoavel	9.6	1.20	1,800
79	**Sala Nº17**	UN HABITAT	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
80	**Sala Nº18**	UN HABITAT	FNAC	KF 180	*R-22*	Razoavel	8.3	1.04	1,556
81	**Sala Nº19**	UNESCO	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
82	**Sala Nº20**	RECEPÇAO	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
83	**Sala Nº21**	FINANCE	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
84	**Sala Nº22**	FINANCE	Westpoint	WSM18E	*R-22*	BOM	6.8	0.85	1,275
85	**Sala Nº23**	FINANCE	LG	LS-	*R-22*	Razoavel	6.5	0.81	1,219
86	**Sala Nº24**	UNV	FNAC	PRECMO2F	*R-22*	Razoavel	9.6	1.20	1,800
87	**Sala Nº25**	UNOPS	LG	PRECMO2F	*R-22*	Razoavel	9.6	1.20	1,800
88	**Sala Nº26**	SERVER	FNAC	KF 125	*R-22*	Razoavel	7.3	0.91	1,369
89	**Sala Nº27**	OIM	FNAC	KF 240	*R-22*	MAU	7.5	0.94	1,406
90	**Sala Nº28**	OIM	LG	HS-	*R-22*	BOM	6.3	0.79	1,181
91	**Sala Nº29**	ICT	LG	HS-	*R-22*	Razoavel	6.3	0.79	1,181
92	**Sala Nº30**	COMUNICATION	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
93	**Sala Nº31**	UNIDO	FNAC	PRECMO2F	*R-22*	MAU	9.6	1.20	1,800
4th Floor									
94		Conference1	LG	S 186 DP	*R-22*	Razoavel	8.3	1.45	2,179
95		Conference2	LG	S 186 DP	*R-22*	Razoavel	8.3	1.04	1,556

Please note the position of the condensing units of the Air Conditioning units.

10.1.2 Lighting System Data & Replacement Analysis

ECM #	Location	Measure Description	Qty	Annual Run Hours On-Peak (hrs)	Annual Run Hours Off-Peak (hrs)	Existing Unit (kW)	Proposed Unit (kW)	Existing Demand (kVA)	Existing Energy (kWh)	Proposed Demand (kVA)	Annual Savings Demand (kVA/mth)	Annual Savings Energy (kWh)	Annual Savings Costs ($)	Install. Costs ($)	Payback (Yrs)
Outside Lighting															
1	Perimeter Wall	Replace 400-Watt Mercury Vapor fixt with 250-Watt Metal Halide stud-mounted fixture	7	4,380		0.45	0.25	3.15	13,797	1.75	1.40	6,132	1,808	$ 2,100	1.2
2	Driveway/Atrium	Pole-mounted 18-Watt Compact Fluorescent Lighting (CFL)	8	4,380		0.018	0.018	0.14	631	0.144	-	-	-	-	-
GND Floor															
1	Garage	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	5	3,000		0.088	0.058	0.44	1,320	0.29	0.15	450	133	$ 150	1.1
1a		18-Watt Compact Fluorescent Lighting (CFL)	5	3,000		0.018	0.018	0.09	270	0.09	-	-	-	-	-
2	Reception	18-Watt Compact Fluorescent Lighting (CFL)	12	3,000		0.018	0.018	0.22	648	0.216	-	-	-	-	-
3	Restaurant	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	10	1,000		0.088	0.058	0.88	880	0.58	0.30	300	88	$ 300	3.4
4	Library	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	13	1,000		0.088	0.058	1.14	1,144	0.754	0.39	390	115	$ 390	3.4
5	Electrical/Phone Control Room	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	1	3,000		0.088	0.058	0.09	264	0.058	0.03	90	27	$ 30	1.1
6	Dispensary	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	8	1,000		0.088	0.058	0.70	704	0.464	0.24	240	71	$ 240	3.4
7	West Africa Institute	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	4	1,000		0.088	0.058	0.35	352	0.232	0.12	120	35	$ 120	3.4
8	Elevator Stairwell	18-Watt Compact Fluorescent Lighting (CFL)	8	1,000		0.018	0.018	0.14	144	0.144	-	-	-	-	-
9	Restrooms	Replace F40T12 (1-40W) lp w/std ballast w/F28T5 (1-28W) lps and 1 electronic ballast.	6	500		0.045	0.030	0.27	135	0.18	0.09	45	13	$ 150	11.3
9a	"	18-Watt Compact Fluorescent Lighting (CFL)	6	500		0.018	0.018	0.11	54	0.108	-	-	-	-	-
Electrical/Generator Room		Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	4	1,000		0.088	0.058	0.35	352	0.232	0.12	120	35	$ 120	3.4

ECM #	Location	Measure Description	Qty	Annual Run Hours On-Peak (hrs)	Annual Run Hours Off-Peak (hrs)	Existing Unit (kW)	Proposed Unit (kW)	Existing Demand (kVA)	Existing Energy (kWh)	Proposed Demand (kVA)	Annual Savings Demand (kVA/mth)	Annual Savings Energy (kWh)	Annual Savings Costs ($)	Install. Costs ($)	Payback (Yrs)
1st Floor															
1	Conference Room	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	4	1,300		0.088	0.058	0.35	458	0.232	0.12	156	46	$ 120	2.6
2	Store	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	1	500		0.088	0.058	0.09	44	0.058	0.03	15	4	$ 30	6.8
3	Offices	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	6	3,000		0.088	0.058	0.53	1,584	0.348	0.18	540	159	$ 180	1.1
4	Rooms - 65, 66,67,68,69,70	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	12	3,000		0.088	0.058	1.06	3,168	0.696	0.36	1,080	318	$ 360	1.1
5	Hallway North	18-Watt Compact Fluorescent Lighting (CFL)	7	500		0.018	0.018	0.13	63	0.126	-	-	-	-	-
6	Hallway South	18-Watt Compact Fluorescent Lighting (CFL)	7	500		0.018	0.018	0.13	63	0.126	-	-	-	-	-
7	Kitchen	Replace F40T12 (1-40W) lp w/std ballast w/F28T5 (1-28W) lps and 1 electronic ballast.	2	500		0.088	0.058	0.18	88	0.116	0.06	30	9	$ 50	5.7
8	Restrooms	Replace F40T12 (1-40W) lp w/std ballast w/F28T5 (1-28W) lps and 1 electronic ballast.	8	500		0.045	0.030	0.36	180	0.24	0.12	60	18	$ 160	9.0
8a	"	18-Watt Compact Fluorescent Lighting (CFL)	8	500		0.018	0.018	0.14	72	0.144	-	-	-	-	-
9	Atrium/Elevator Lobby	18-Watt Compact Fluorescent Lighting (CFL)	6	2500		0.018	0.018	0.11	270	0.108	-	-	-	-	-

ECM #	Location	Measure Description	Qty	Annual Run Hours On-Peak (hrs)	Annual Run Hours Off-Peak (hrs)	Existing Unit (kW)	Proposed Unit (kW)	Existing Demand (kVA)	Existing Energy (kWh)	Proposed Demand (kVA)	Annual Savings Demand (kVA/mth)	Annual Savings Energy (kWh)	Annual Savings Costs ($)	Install. Costs ($)	Payback (Yrs)
2nd Floor															
1	Room 32	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	4	3,000		0.088	0.058	0.35	1,056	0.232	0.12	360	106	$ 120	1.1
2	Room 33, 36, 37, 39, 41, 42, 43, 44	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	8	3,000		0.088	0.058	0.70	2,112	0.464	0.24	720	212	$ 240	1.1
3	Room 38,	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	2	3,000		0.088	0.058	0.18	528	0.116	0.06	180	53	$ 60	1.1
4	Room 45	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	12	3,000		0.080	0.057	0.96	2,880	0.684	0.28	828	244	$ 360	1.5
4a	"	18-Watt Compact Fluorescent Lighting (CFL)	1	2,500		0.018	0.018	0.02	45	0.018	-	-	-	-	-
5	Resident Coordinator	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	2	3,000		0.088	0.058	0.18	528	0.116	0.06	180	53	$ 60	1.1
6	Elevator Lobby	18-Watt Compact Fluorescent Lighting (CFL)	2	2500		0.018	0.018	0.04	90	0.036	-	-	-	-	-
7	Rooms 46, 47,48, 49, 51, 52, 53, 54, 55	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	12	3,000		0.088	0.058	1.06	3,168	0.696	0.36	1,080	318	$ 360	1.1
8	Rooms 57, 58	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	5	3,000		0.088	0.058	0.44	1,320	0.29	0.15	450	133	$ 150	1.1
9	Rooms 60, 61	Replace F40T12 (2-36W) lp w/std ballast w/F28T5 (2-28W) lps and 1 elect ballast	3	3,000		0.088	0.058	0.26	792	0.174	0.09	270	80	$ 90	1.1
10	Restrooms	Replace F40T12 (1-40W) lp w/std ballast w/F28T5 (1-28W) lps and 1 electronic ballast.	8	500		0.045	0.030	0.36	180	0.24	0.12	60	18	$ 200	11.3
10a	"	18-Watt Compact Fluorescent Lighting (CFL)	8	500		0.018	0.018	0.14	72	0.144	-	-	-	-	-
11	Hallway South	18-Watt Compact Fluorescent Lighting (CFL)	7	1,500		0.018	0.018	0.13	189	0.126	-	-	-	-	-
12	Hallway North	18-Watt Compact Fluorescent Lighting (CFL)	7	2,500		0.018	0.018	0.13	315	0.126	-	-	-	-	-

ECM #	Location	Measure Description	Qty	Annual Run Hours On-Peak (hrs)	Off-Peak (hrs)	Existing Unit (kW)	Proposed Unit (kW)	Existing Demand (kVA)	Existing Energy (kWh)	Proposed Demand (kVA)	Annual Savings Demand (kVA/mth)	Energy (kWh)	Costs ($)	Install. Costs ($)	Payback (Yrs)
Third Floor															
1	World Health Organization	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	7	3,000		0.088	0.058	0.62	1,848	0.406	0.21	630	186	$ 210	1.1
1a	"	Replace F40T12 (4-18W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	1	3,000		0.075	0.058	0.08	225	0.058	0.02	51	15	$ 30	2.0
2	Drug & Crime Unit	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	7	3,000		0.088	0.058	0.62	1,848	0.406	0.21	630	186	$ 210	1.1
3	UNIDO Offices	Replace F40T12 (4-18W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	8	3,000		0.075	0.058	0.60	1,800	0.464	0.14	408	120	$ 240	2.0
3a	"	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	6	3,000		0.088	0.058	0.53	1,584	0.348	0.18	540	159	$ 180	1.1
4	Reception	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	2	3,000		0.088	0.058	0.18	528	0.116	0.06	180	53	$ 60	1.1
5	Rooms - 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	13	3,000		0.088	0.058	1.14	3,432	0.754	0.39	1,170	345	$ 390	1.1
6	Restrooms	Replace F40T12 (1-40W) lp w/std ballast w/F28T5 (1-28W) lps and 1 electronic ballast.	8	500		0.045	0.030	0.36	180	0.24	0.12	60	18	$ 200	11.3
7	"	18-Watt Compact Fluorescent Lighting (CFL)	8	500		0.018	0.018	0.14	72	0.144	-	-	-	-	-
8	Hallway South	18-Watt Compact Fluorescent Lighting (CFL)	7	2,500		0.018	0.018	0.13	315	0.126	-	-	-	-	-
9	Hallway North	18-Watt Compact Fluorescent Lighting (CFL)	7	2,500		0.018	0.018	0.13	315	0.126	-	-	-	-	-
10	Elevator Lobby	18-Watt Compact Fluorescent Lighting (CFL)	2	500		0.018	0.018	0.04	18	0.036	-	-	-	-	-
11	Services	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	6	3,000		0.088	0.058	0.53	1,584	0.348	0.18	540	159	$ 180	1.1
12	Rooms - 1, 2, 3, 4, 5, 6	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	6	3,000		0.088	0.058	0.53	1,584	0.348	0.18	540	159	$ 180	1.1
13	Rooms 65, 66, 67, 68, 69, 70	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	12	3,000		0.088	0.058	1.06	3,168	0.696	0.36	1,080	318	$ 360	1.1
14	Program Office	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	1	3,000		0.088	0.058	0.09	264	0.058	0.03	90	27	$ 30	1.1
15	Kitchen	Replace F40T12 (1-40W) lp w/std ballast w/F28T5 (1-28W) lps and 1 electronic ballast.	2	1,500		0.045	0.030	0.09	135	0.06	0.03	45	13	$ 50	3.8

ECM #	Location	Measure Description	Qty	Annual Run Hours On-Peak (hrs)	Annual Run Hours Off-Peak (hrs)	Existing Unit (kW)	Proposed Unit (kW)	Existing Demand (kVA)	Existing Energy (kWh)	Proposed Demand (kVA)	Annual Savings Demand (kVA/mth)	Annual Savings Energy (kWh)	Annual Savings Costs ($)	Install. Costs ($)	Payback (Yrs)
4th Floor															
1	Conference Room	Retrofit F40T12 (4-18W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast	12	2000		0.075	0.057	0.9	1,800	0.684	0.22	432	127	$ 360	2.8
2	Hallway	18-Watt Compact Fluorescent Lighting (CFL)	2	3,000		0.018	0.018	0.0	108	0.036	-	-	-	-	-
3	Restrooms	Retrofit F40T12 (1-40W) lp w/std ballast w/F28T5 (1-28W) lps and 1 electronic ballast.	2	500		0.045	0.030	0.1	45	0.06	0.03	15	4	$ 50	11.3
3a	"	18-Watt Compact Fluorescent Lighting (CFL)	2	500		0.018	0.018	0.0	18	0.036	-	-	-	-	-
4	Water Storage Room	Replace F40T12 (2-40W) lp w/std ballast w/F28T5 (2-28W) lps and 1 electronic ballast.	2	1,000		0.088	0.058	0.2	176	0.116	0.06	60	18	$ 60	3.4
5	East Stairwell	18-Watt Compact Fluorescent Lighting (CFL)	6	500		0.018	0.018	0.1	54	0.108	-	-	-	-	-
	Total							**24**	**61,060**	**17**	**8**	**20,367**	**$ 6,006**	**$ 8,930**	**1.5**

Existing four-foot 2-lamp fluorescent Fixture

Existing 1-lamp Wrap-Around Lighting Fixture

Solar PV Construction Project Analysis

No.	Item	Spec. & Type	Unit	Qty.	Remark
1	Grid-connected inverter	XNY-GC30K3	pc	1	
2	Thin film solar module	100Wp	pc	252	
3	Combiner box	XNY-HL 1401B	pc	1	
4	Cable for PV	PFG1169-1*4	m	1000	
5	Cable for electric power	ZR-YJV-1KV-2*35	m	100	
6	Low voltage distribution box	25 kW	pc	1	With measure of electric energy
	Sub-total	**CIF Praia**			**USD 68,590**
8	Labour – transport & installation				USD8,477
9	Roof civil Works				USD4,978
	Total				**USD82,045**
Note: this quotation is valid for 15 days, from Feb.20, 2012 to March 10, 2012.					

11.0 ATTACHMENTS – Equipment and Installation Specifications

ATTACHMENT “B” LIGHTING REPLACEMENTS

This scope of work is to perform energy saving lighting replacements at the One UN Building per the Attachment “A”.

The installer of the lighting system is herein referred to as the “subcontractor”.

The following pertains to the entire installation described above:

- This subcontract is to perform a COMPLETE lighting replacement of the One UN Building
- Subcontractor shall obtain all the lighting material to be installed from the UN building’s Operation Manager. Other items such as wire, wire nuts, paint, etc shall be the responsibility of the contractor
- Subcontractor is responsible for entire building lighting replacements as well as all costs associated with missed areas, omissions and errors in the survey
- All costs for permits and inspections are included in the subcontract price.
- All materials furnished will be new in every respect. All conductors shall be copper. All conductors shall be installed in approved conduits
- Subcontract price includes all applicable taxes
- It is agreed that the unit prices contained in the attached scope of work can be used by ECREEE in additions and deletions to the project throughout the duration of same. All additions and/or deletions must be approved in writing by ECREEE prior to implementation.
- It is anticipated that most of the work will be accomplished during unoccupied hours. All costs for after hours work is included in the subcontract price.
- Properly dispose of all trash and debris. Subcontract price includes all fees and charges associated with storage and removal of related trash and debris.
- Subcontractor shall provide all necessary materials, tools, equipment, machinery, labour and supervision to accomplish work.
- All work is to be in strict accordance with all state and local codes and ordinances
- Workmanship shall be warranted for one year from date of acceptance.
- Appropriate insurance and bonding will be provided by subcontractor.
- Subcontractor will be responsible for receipt and storage of material ordered by ECREEE for the project. Subcontractor shall inventory material and provide receipts of acceptance to ECREEE within 48 hours. Subcontractor shall provide adequate security to safeguard material against theft, weather or other eventuality and shall provide ECREEE with a running total of material used and keep ECREEE updated on material available status.
- Upon conclusion of project, all material not installed continues to be the property of ECREEE and subcontractor shall provide ECREEE with an inventory of contents.
- Subcontractor shall coordinate and obtain approval for jobsite storage or materials, tools, equipment, etc. with the building manager/superintendent and ECREEE. If additional storage is required it is subcontractor’s responsibility arrange that with ECREEE

- It is agreed that adequate manpower, fully trained, will be provided to meet ECREEE's fast track schedule. If subcontractor should fall behind schedule, subcontractor shall immediately take whatever steps are necessary (additional manpower, crews, etc.) to meet and maintain the ECREEE's schedule. If subcontractor is not found to be in compliance within two (2) working days, ECREEE reserves the right to supplement the subcontractor's workforce and deduct the cost from the contract
- Under no circumstances is the normal operation of any building or building affairs of the owner/occupants to be impaired or disrupted unless scheduled and approved in advance by the UN contract officer
- Thoroughly clean and restore to original condition all work areas at the end of each day or when the task is complete, whichever is sooner. Do not block or restrict access to any area at any time without prior approval of the UN contract officer.
- Subcontractor shall coordinate and obtain approval for jobsite access with the UN contract officer and ECREEE
- Jobsite safety is of the utmost concern to ECREEE on this project.
    - Report any unsafe jobsite condition to ECREEE immediately
    - Submit a complete accident report on any serious job injury within 24 hours of such occurrence.
    - Hold meaningful jobsite safety meetings at a minimum of once a week.
- Provide full time project manager to supervise personnel during the installation period. This is to include daily walk-through and inspections at the request of ECREEE. Subcontractor shall provide a written weekly status report indicating work completed, work schedule, and any coordination issues requiring UN contract officer's assistance.
- Unless specifically noted, ECREEE's obligations expressly exclude any work or services of any nature associated or connected with the identification, abatement, cleanup, control, removal, or disposal of hazardous materials or substances including but not limited to asbestos or PCB's, in or on the premises. Subcontractor will not enter into or undertake any such action for or on behalf of ECREEE

- ECREEE will contract for PCB ballast and lamp recycling. Subcontractor and ECREEE will coordinate for removal from the jobsite. The PCB ballasts will be disposed of by current local and/or national Environmental Agency requirements.
- Subcontractor shall provide to ECREEE a copy of the building's footprint containing the number and type of fixture replacements by room or area.
- In areas that presently have multi-level switching for lighting circuits, subcontractor shall maintain this function and through ECREEE obtain advance approval from the UN to deviate from this method of operation.
- Subcontractor shall be responsible for the image portrayed from their employees. ECREEE reserves the right to demand removal of any such employee found to be portraying any improper image or for misconduct. No smoking is allowed within any structure at the building sites and is grounds for removal.
- Subcontractor's personnel shall have no unwarranted verbal or nonverbal communication with any UN employee or client.

- Subcontractor shall submit two (2) copies of their MSDS and safety manuals within five (5) days of award of subcontract.
- Subcontractor shall provide a replacement work schedule within three (3) days upon award of subcontract.
- Subcontractor shall submit progress billing requests by the first of the month with 10 % retention shown. Payment will be made within 45 days of invoice date after work in place approval is received by ECREEE project personnel.
- Subcontractor is responsible for all efforts necessary to gain permit approval for the job

ATTACHMENT "C" DUAL TECHNOLOGY OCCUPANCY SENSOR

A. The designated installer of the sensors is herein referred to as the 'Subcontractor'.

- The Subcontractor shall be familiar with such installation projects in experience. The subcontractor shall be supplied with the materials for the completion of the job by the UN/ECREEE personnel.
- The subcontractor shall verify with the project manager that the under-specified technical highlights are for most part provided with the material supply.
- The subcontractor shall make sample installation for inspection by the project manager before continuing to completion.

The following are the Technical and Operational Specifications of the Sensors:

1. Sensor shall be available with a two-way coverage pattern.
2. Sensor shall activate the electrical load upon entry into the controlled area and deactivate it after the area is vacated.
3. Sensor shall be able to detect the moderate types of motion (that is picking up a telephone, raising a hand in class) of people seated anywhere in classrooms, offices and conference rooms.
4. Sensor shall maintain a constant level of sensitivity to motion regardless of changes in environmental conditions including airflow.
5. Sensor shall have the ability to resist false activation in high airflow.
6. Sensor shall utilize passive infrared sensing technology to activate lights and other equipment connected to it.
7. Sensor shall maintain lighting in one of two selectable modes: (1) either (passive infrared or ultrasonic technology), (2) both (passive infrared and ultrasonic technology).
8. Sensor shall cover areas from 60 to 160 m^2 of half-step motion and 80 m^2 of moderate motion in rooms without partitions.
9. Sensor shall contain timing circuitry to provide adjustable "time to lights off" delay of 15 seconds or less (for installer checkout) to 30 minutes. A 10-minute delay shall automatically default if the potentiometer is left at minimum.
10. Sensor shall incorporate separate, concurrent time delays for ultrasonic and infrared detectors.
11. Sensor shall provide a ten-second "grace period" that allows lights to be turned on by motion anywhere in a room after they are turned off due to inactivity.
12. Sensor shall have capacity to be wired to a momentary pushbutton switch for manual on/off control, or to a relay (up to 25 Amp) for start/stop control of selected circuitry.

13. Sensor shall be fully self-resetting in Automatic mode; lights turned off manually via the pushbutton switch shall stay off while the room remains occupied. After the room is vacated and the time delay and grace period have elapsed, lights shall turn on automatically upon re-entry. The BAS relay shall remain active as long as occupancy is detected.

14. Sensor shall self-adjust sensitivity (range) and time delay in real-time to optimize performance.

15. Sensor shall include a manual on option which requires occupants to turn on lights and activate BAS relay manually via a wall switch.

16. Sensor shall provide a Building Automation system (BAS) interface via (1) a built-in isolated Form C relay output, (2) an open collector output, with or without pull-up option, or (3) a direct BAS connection.

17. Sensor shall provide a "Zero Time Delay" contact closure for systems, eg. Air conditioners, with an internal timing function.

18. Sensor shall provide a bi-Color LED to indicate which technology detects motion.

19. Sensor shall provide a manual override switch, which closes the BAS relay and allows the lighting load to be turned on without tools in the event of sensor malfunction.

20. Sensor electronics shall be replaceable, in the event of failure, without disturbing hard-wiring or sensor mounting.

21. Sensor housing shall comply with UL 94V0 or equivalent specification and shall be equipped with a protective grill to shield the detectors from damage.

22. Sensor shall be UL (or equivalent specification) listed.

23. Sensor shall be designed for parallel wiring to allow coverage of large areas.

24. Sensor shall perform within the US FDA's guidelines (or equivalent specification) for ultrasonic devices.

EXHIBIT “D” SOLAR PHOTOVOLTAIC (PV) SYSTEM SPECIFICATIONS

The design of the on-site solar photovoltaic (PV) system will be the responsibility of the subcontractor and/or Licensee; however, the system must be compliant with applicable Cape Verde (CV) design guidelines and UN technical specifications.

This Exhibit delineates the minimum technical and installation specifications required by the ECREEE/UN for the Project. It is the intent of these specifications to insure that the PV systems installed are consistent with and adhere to any and all CV Building Codes and standards, ECREEE Renewable Energy programs, applicable utility rules and tariffs, and any and all Praia, CV technical and installation specifications and guidelines in existence.

Bidders are advised to be familiar with these rules, requirements and specifications as they pertain to the installation of solar PV systems in CV. In addition to the requirements set out in this Exhibit, the project requirements for design, construction and operation and maintenance are set out elsewhere must be adhered to for compliance.

PV Modules

- PV modules must be listed on any applicable ECREEE’s list of preferred Solar PV module list, and must qualify for eligibility under the any CV’s such program.

- System must comply with IEEE 1262 “Recommended Practice for Qualifications of Photovoltaic Modules” or equivalent.

Electric Power Requirements:

- Power provided must be compatible with the onsite distribution system
- Power capacity should be measured at the inverter AC output using the PV USA Test Conditions (PTC), i.e. 1,000 Watts/m^2, 20 °C ambient temperature and wind speed of 1 m/s.
- The System must include all the hardware needed for the solar PV.
- All systems must be installed in accordance with all applicable requirements of local electrical codes and the US National Electrical Code (NEC), including but not limited to Article 690, “Solar Photovoltaic Systems” and Article 705 - “Interconnected Electrical Power Production Sources” or the EU equivalent.
- Systems must be designed and installed using UL or ETL listed components, including mounting systems.
- Modules must be certified to UL 1703 - “Flat-Plate Photovoltaic Modules and Panels” or equivalent.
- Inverters must comply with the following requirements or EU equivalent:
    - IEEE 929-2000 - “Recommended Practice for Utility Interface of Photovoltaic Systems”
    - UL 1741 - “Standard for Static Inverters and Charge Controllers for use in Photovoltaic Systems”
    - Listed on the CEC list of eligible inverters

- Other technical codes that will apply include:
  - US AMSE PTC 50 (solar PV performance)
  - ANSI Z21.83 (solar PV performance and safety)
  - US NFPA 853 (solar PVs near buildings) or equivalent
  - US NEPA 70 (electrical components) or equivalent
  - IEEE 1547 (interconnections) or equivalent
  - US National Electrical Safety Code - ANSI C2 - 1999 or equivalent
  - All applicable CV Building Codes and requirements

- All Balance of Systems (wiring, component, wiring, conduits, and connections) must be suited for conditions for which they are to be installed. It is the preferred by ECREEE that when possible, inverters are located inside out of the weather in a minimum NEMA 12 enclosure or equivalent. If inverters are in exterior locations, they shall be installed in all-weather NEMA 4X enclosures or equivalent. An interval data meter must be installed to measure the AC output of the inverter. This meter should be located in a location accessible to CV Building inspectors, UN and ECREEE officials.

- Interconnection must comply with any applicable to local CV regulations on such Interconnection Standards for non-Utility generation. Licensee will assist the ECREEE and the UN in preparing and submitting appropriate interconnection agreements with Electra of CV. This shall be done at no cost or liability to ECREEE.

Meters

- Licensee will provide revenue grade Interval Data Recording (IDR) meters complete with industry standard telemetry for communication with Ethernet, cellular or other common output capabilities.

- Licensee will provide connection to the UN Building's Energy Management System (EMS) for the purposes of metering, monitoring and data collection of solar production.

- Meters must connect to a monitoring/data collection recording solar production through Time-of-Use (TOU) increments applicable to the local utility standards, with a minimum 15 minute intervals or to match the Electra's mode of metering.

Structural Requirements

- All structures and structural elements, including array structures, shall be designed in accordance with all applicable CV Building Codes and standards pertaining to the erection of such structures.
- The licensee shall provide structural calculations, stamped by a licensed professional structural engineer in good standing in CV.
- All structural components, including array structures, shall be designed in a manner commensurate with attaining a minimum 25-year design life. Particular attention shall be given to the prevention of corrosion at the connections between dissimilar metals.
- The structural design should provide for easy and cost effective repair or replacement of the roof. The Licensee shall be expected to remove and replace roof-mounted solar systems no more than one time during the contract period at no expense to the United Nations, to allow for major roofing maintenance, including installing a new roof.

- Any roof penetrations must be designed and constructed in collaboration with the roofing professional or manufacturer responsible for the roof and roofing material warranty for the specific site, to ensure that the existing roof warranty is not invalidated by the installation of the solar PV system.

- For rooftop installations where there is no parapet or the parapet is less than 1.5 metres, a 2-metre safety zone from the roof edge to the PV system must be maintained. A 1-metre clear path of travel must be maintained around all rooftop equipment.

Lighting Requirements

The Licensee will be responsible to carefully remove and return to the UN Facility Management any light standards that conflict with PV parking canopy/trellis systems. During the term of the agreement, the Licensee must install and maintain a lighting system that provides a minimum of 5 lox on the pavement under the canopy/trellis and a minimum of 1 lux on pavement outside the canopy/trellis footprint.

Operation and Maintenance

The Licensee will be responsible for the operation and all maintenance of the solar PV system at the Licensee's own cost. The Licensee shall operate and maintain the solar system so as not to disrupt the operation of the facility per the Solar License Agreement.

The Licensee shall provide notification to the University as early as practical, but in no event less than five days, prior to any planned maintenance and repairs. The Licensee will provide a minimum of ten days notification to the UN Facility Management if any planned repairs or maintenance that will result in any disruption to the building electrical load.

The UN Facility Management will use all reasonable efforts to maintain the facilities in good condition and repair to be able to receive and utilize the solar electricity supplied by the proposed project.

All parking canopy PV systems shall include night lighting as part of the design. The amount of lighting required will be in accordance with the UN building design guidelines.

Maintenance for the solar PV system shall be outlined and included in the Solar License Agreement (SLA) and Solar Power Purchase Agreement (SPPA). All system warranties and workmanship guarantees will be in effect during the SLA and the SPPA periods.

As part of the acceptance of the solar PV system the licensee shall instruct and provide operations manuals on how to shut down the solar PV system in the event of an emergency. The Licensee shall insure that the UN Building emergency first responders can easily identify what to do in the event of an emergency and able to perform these tasks quickly and safely.

Labelling

Label whether the system is stand-alone, grid-tied or hybrid.

- Conductor sizes.
- _ Conductor insulation types (i.e., THHN, THWN, direct burial cable, etc.).
- _ Conductor material (i.e., copper/aluminum).

- _ Conduit sizes.
- _ Conduit material (i.e., non-metallic, EMT, etc.).
- _ Over-current device ratings.
- _ Existing and new panel amperage ratings (buss ratings).
- _ Series and parallel configuration of the module connections.

Equipment Requirements

Provide the following general information.

- Module short circuit current ratings.
- Module open circuit voltage ratings.
- Module series fuse ratings.
- Inverter output circuit current rating.
- Inverter UL listings.
- All associated documentation (i.e., batteries, inverters, disconnects,
- Modules, charge controllers, over-current devices etc.).
- Method of grounding for modules and array.

Note: Voltage correction factor is based on 125% (USA, 2008 NEC Table 690.7) or equivalent.

Panels

Roof Mounted Panels

Provide the Following Information:

- An Engineer's evaluation regarding the dead-load capability of the existing roof structure and its ability to support the added weight of the PV panels.
- For flat roof installations provide method of repair for roof penetrations.

Pole or Ground Mounted Panels

Provide The Following Information:

- Site Plan Review approval
- Site Plan to include the following:
- Location of panel(s) on property.
- Dimensions from panels to property lines.
- Dimensions from panels to other structures on the property and property easements.
- Engineered footing design.

Solar PV Technical Specifications

- **Technical parameter for main equipments - 100Wp Thin film solar module**

✧ Peak power: 100Wp

✧ Optimum operating voltage: 105V

✧ Open-circuit voltage: 136V

✧ Optimum operating current: 0.95A

✧ Short circuit current: 1.17A

✧ System max. voltage : 1000V

✧ Temperature coefficient of open-circuit voltage: -0.28V%/℃

XNY-GC30K3 Grid-connected inverter

Technical characteristic:

➢ Sine wave current output

➢ High conversion efficiency

➢ MPPT

➢ MPPT efficiency >99%

➢ Voltage input at wide range

➢ Frequency transformer isolation

➢ Perfect protection function and high system reliability

➢ Various communication interface

➢ Simple installation and operation

➢ Optional multilingual LCD

➢ Settable the protection and operational factor

Technical parameter:

DC side:

Max. DC voltage: 880Vdc

Max. Power voltage tracking range: 450—820Vdc

Max. DC power: 33KWp

Max. Input current: 80A

Max. Input loop：1

AC side:

Output power: 30KW

Rated grid voltage: 310—450Vac

Rated grid frequency: 50/60Hz

Total current waveform distortion rate: <3%（rated power）

Power factor: >0.99（rated power）

System

Max. Efficiency: 96%

Europe efficiency: 95%

Protection grade: IP20（indoor）

Internal power consumption at night: 0W

Operating temperature: -20℃—+40℃

Cooling-down method: forced air cooling

Relative humidity: 0-95%，non-condensation

Display: LCD

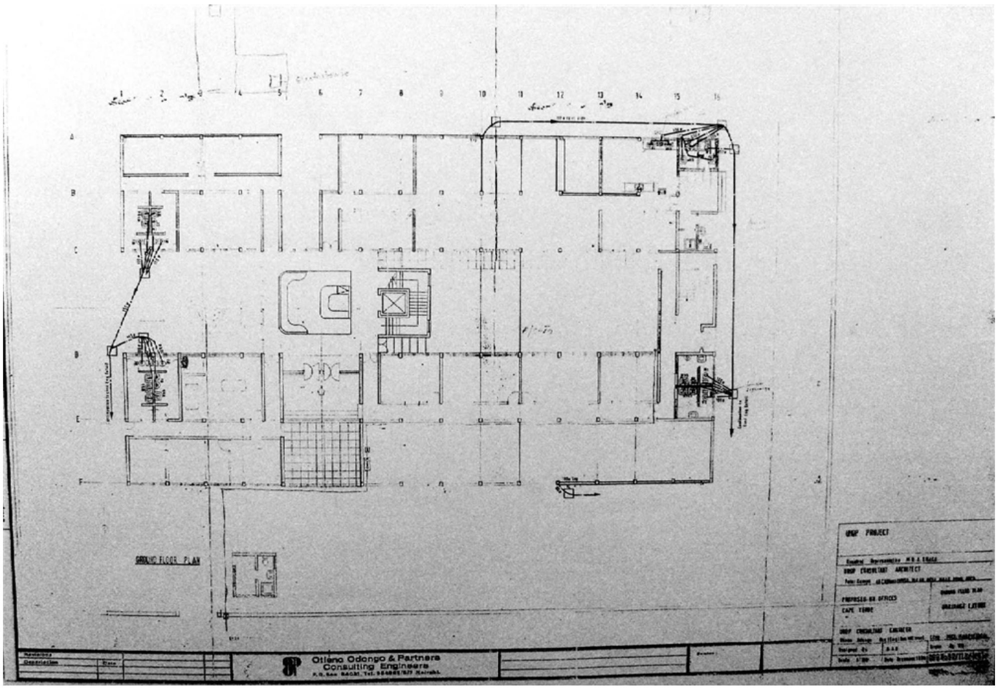
Communication interface: RS232/485、Ethernet/GPRS

Mechanical parameters

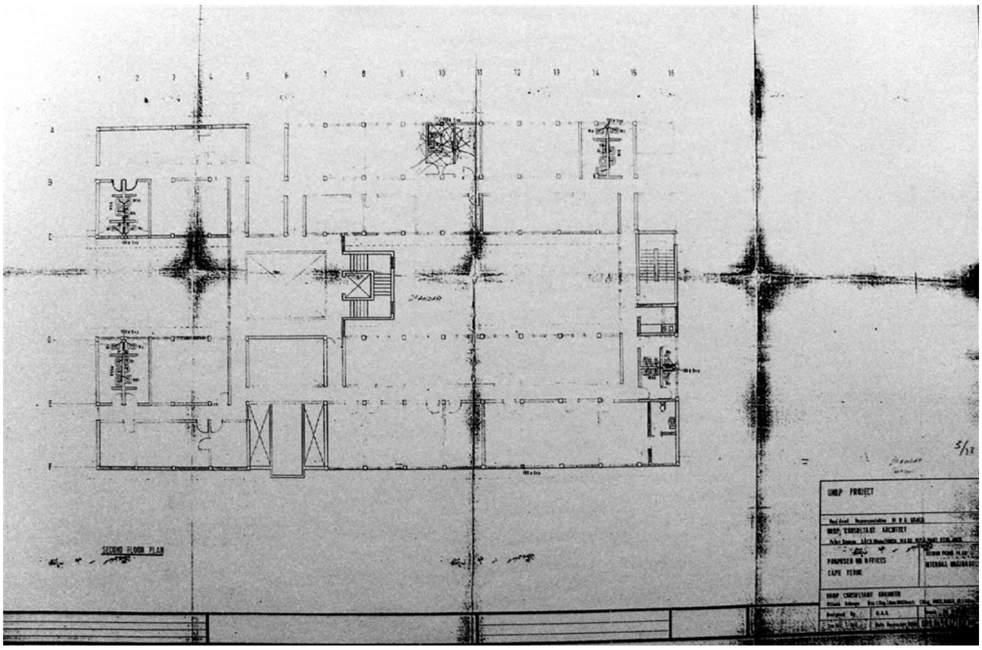
W/H/D: 820*1964*646mm

Weight: 4000Kg

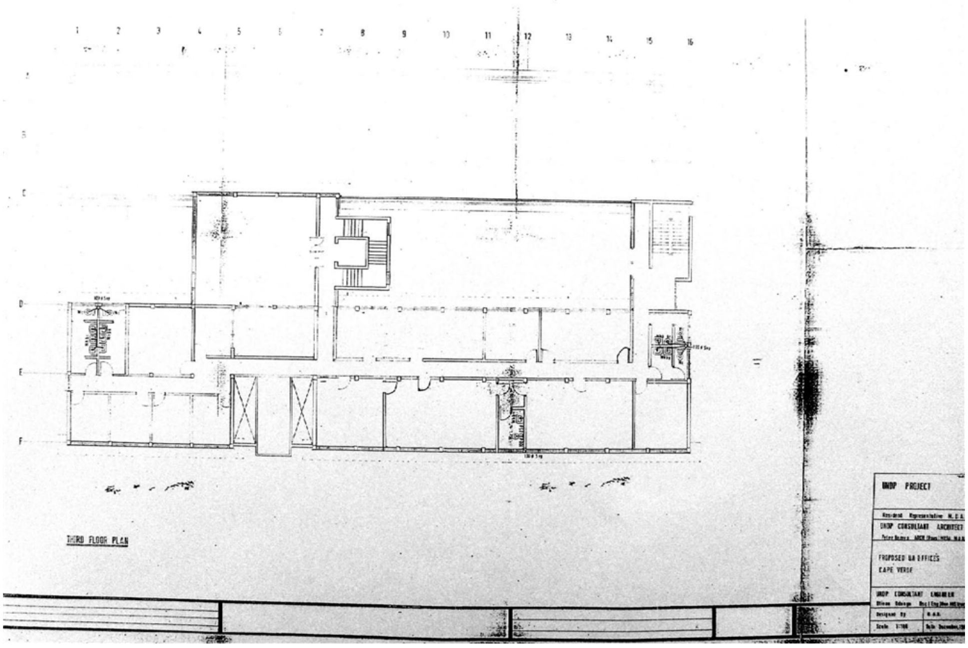
12.0 Building Floor Plans



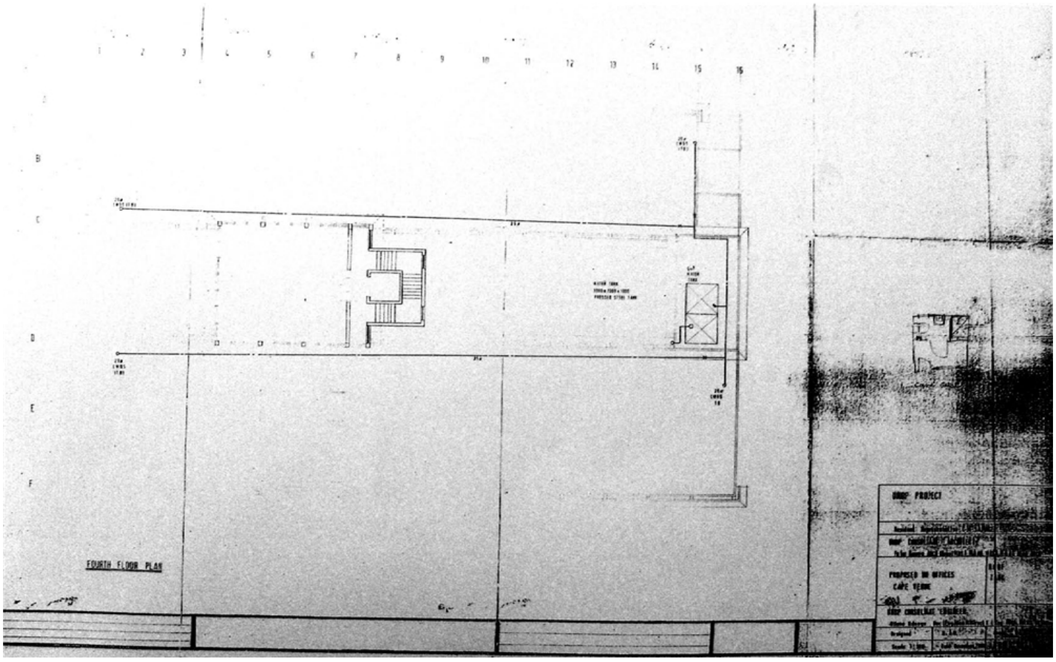
Ground Floor Plan



Second Floor Plan



Third Floor Plan



Fourth Floor Plan