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OPERATION & MAINTENANCE **PRICING SCHEDULE**

Client:

Project Detail: Grid Tie Solar System

Report Recipient:

Contractor: **Knights Energy Limited**

16th May 2019

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Great Jubilee Centre, Nairobi
Email: info@knightsandapps.com
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SERVICES UNDER THIS CONTRACT

The Operation and Maintenance services provided by Knight and Apps LTD includes:

Preventive Maintenance

- Panel Cleaning
- Vegetation Management
- Water Drainage
- Retro-Commissioning- Plant tests such as IV-Curves
- Upkeep of Data Acquisition and Monitoring Systems
- Upkeep of Power Generation Systems (Inverter Servicing, BOS Inspection, Electrical systems)

Corrective/ Reactive Maintenance

- On-site Monitoring and Mitigation
- Critical Reactive Repair

Condition-Based Maintenance

- Active Plant Monitoring to include Remote Monitoring
- Warranty Enforcement (Planned and Unplanned)
- Equipment Replacement (Planned and Unplanned)

General Trouble-shooting, Repairs and Customer Service

These services are provided at the costs specified below:

System Capacity	Unit Cost
-kWp	(USD) / W + VAT

The annual cost for provision of electrical operation and maintenance services for the installed -kWp Grid Tie Solar PV system is **USD - (- Kenyan Shillings) + VAT.**

Dated:

Signed, for and on behalf of **Client:** .....

Name:	Title:	Signature:
.....	.....	.....
Name:	Title:	Signature:
.....	.....	.....

Signed, for and on behalf of **KNIGHTS AND APPS LTD** .....

Name:	Title:	Signature:
ROMANO FRANCIS	DIRECTOR	.....

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SOLAR PV PLANT OPERATION AND MAINTENANCE SCHEDULE

SERVICES

Knights Energy shall carry out regular maintenance/inspection of the entire PV system. This shall include both regular and irregular site visits and 24/7 remote online monitoring to ensure the peak efficiency of the plant is attained as per required standards.

SYSTEM MONITORING AND ON-CALL SERVICE TECHNICIAN

Knights Energy will provide remote monitoring of solar system operations on the Sunny Portal Website and track changes and respond to power outages within three business days. This includes the services outlined below:

Description of Works	Frequency
Online Remote System Monitoring	24 hours / 7 days per week
On-Call System Service Technician	On request
Electrical Inspection	Three times a Year

SYSTEM MONITORING EQUIPMENT

On an annual basis the SMA monitoring equipment will be tested by Knights Energy to verify that it is operating as intended.

EXCLUDED SERVICES

1. Any installation of additional monitoring equipment added if site conditions change for reasons beyond Knights Energy's specifically, interference caused by any additions or repairs to the premises after the start of the term.
2. Parts or equipment that was not specified in the Master Engineering, Procurement and Construction Agreement entered into by the Parties, and installed by Knights Energy.
3. In the event that any manufacturer of materials, equipment or similar items relating to the System is not able or willing to honor its product warranty, Knights and Apps shall not be responsible for the costs of any such manufacturer's components.

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APPENDIX 1.0

SCOPE OF WORKS FOR GRID-TIE SOLAR PV WORKS

REF	DESCRIPTION	AFTER 4 MONTHS	BI-ANNUALY	ANNUALLY
1.	**Scope of Works**			
1.1.	**General Housekeeping**			
1.1.1.	If ground mounted, visually inspect perimeter fence/gate for signs of damage, corrosion, vandalism...etc.		✓	
1.1.2.	If ground mounted, visually inspect entire site for debris/litter. Collect and remove from site (On Demand)		✓	
1.1.3.	If a residential/commercial development record and inform any variance in condition of the site. (I.E construction works are under way, residential units vacated, signs of squatters... etc.)	✓		
1.2.	**Software Upgrades(on demand)**			
1.2.1.	Upgrade equipment software as required for the following: - Inverters - Solar controllers - Routers - Data Loggers	✓		
1.3.	**Inverter Maintenance**			
1.3.1.	General Visual Inspection of the inverters and auxiliary equipment for any anomalies	✓		
1.3.2.	Record and validate production values from the Human Machine Interface (HMI) display	✓		
1.3.3.	Visual Inspection and functionality test of all protective and safety equipment: - Leakage current circuit breakers - Line circuit breakers - Power switches	✓		
1.3.4.	Record and validate open circuit voltages	✓		
1.3.5.	Record and validate short circuit currents	✓		
1.3.8.	Record last logged system errors	✓		
1.3.9.	Clean filters	✓		
1.3.10.	Clean the inside of the cabinet	✓		

REF	DESCRIPTION	AFTER 4 MONTHS	BI-ANNUALY	ANNUALLY
1.3.11.	Test fans for proper operation	✓		
1.3.12.	Visual Inspection of all fuses	✓		
1.3.13.	Thermo-graphic photography of the fuses to check for hot spots	✓		
1.3.14.	Check torque on terminations	✓		
1.3.15	Check gasket seal	✓		
1.3.16	Confirm warning labels are in place	✓		
1.3.17	Look for discoloration from excessive heat buildup	✓		
1.3.18.	Check integrity of lightning arrestors	✓		
1.3.19.	Check continuity of system ground and equipment grounding	✓	✓	
1.3.20.	Check mechanical connection of the inverter to the wall or ground	✓	✓	
1.3.21.	Check internal disconnect for proper operation	✓	✓	
1.3.22.	Verify that current software is up to date	✓	✓	
1.3.23.	Document findings for all work performed	✓	✓	
1.3.24.	Visual inspection of locking mechanism, check for signs of corrosion, vandalism...etc. Spray locking mechanism with preferred lubricant	✓	✓	✓
1.4.	**Mounting Systems**			
1.4.1.	Remove bird nests/vermin from mounting structure	✓	✓	✓
1.4.2.	Inspect structure stability (Random Sample) Visual Inspection of the following for sign of bending or misalignment: - Racking support structure- Horizontal rails - Tilted purlins - Piles	✓	✓	✓
1.4.3.	Inspect structure for corrosion (Random Sample)	✓	✓	✓
1.4.4.	Inspect structure for external damages (Random Sample)	✓	✓	✓
1.4.5.	Inspect earth conductor connection to the structure (Random Sample)	✓	✓	

REF	DESCRIPTION	AFTER 4 MONTHS	BI-ANNUALY	ANNUALLY
1.4.6.	Check tightness of the module clamps to the structure (Random Sample)		✓	
1.4.7.	Inspect pile/foundations for signs of settlement as well as gaps between the pile and the soil indicating movement caused by dynamic loads e.g. wind			✓
1.4.8.	Check that the tilt angle is in line with the specification			✓
1.4.9.	Check the module to module spacing is a minimum of > 10mm			✓
1.4.10.	Check tightening torques and re-tighten to the correct torque for interconnection screws as per supplier's specification and mark the new position in case of a loose screw		✓	
1.4.11.	Check tightness and integrity of cable protection sleeves and sealing compound leading to junction box, repair if needed.		✓	
1.4.12	In roof-mounted systems, check the integrity of the penetrations and check for water ingress.		✓	
1.5.	**PV Modules**			
1.5.1.	PV module cleaning- with professional cleaning tools	Every two months	✓	✓
1.5.2.	Inspect PV modules for fractures, browning and moisture penetration		✓	
1.5.3.	Inspect modules for signs of damage, vegetation obstruction/shading or abnormal soiling		✓	✓
1.5.4.	Thermography and remedy for hotspots		✓	
1.6.	**Cabling**			
1.6.1.	Visually inspect all DC cable for any degradation, cracking, defects, pulling out of connections and damage		✓	
1.6.2.	Visually inspect all AC cable for any degradation, cracking, defects, pulling out of connections and damage		✓	
1.6.3.	Visually inspect all Communication cables for degradation, cracking, defects, pulling out of connections and damage		✓	
1.6.4.	Visual inspection of trench levels and that the soil has not eroded		✓	
1.6.5.	Sporadic inspection of string and wire harnesses for signs of physical damage, loose connections or poor fastening		✓	

REF	DESCRIPTION	AFTER 4 MONTHS	BI-ANNUALY	ANNUALLY
1.7.	**Distribution Boards**			
1.7.1.	Inspect junction boxes/DB Boards for: - Tightness of connections - Water accumulation/build up - Integrity of lid seals - Integrity of cable entrance/glands - Integrity of clamping devices		✓	
1.7.2.	Verify operation of CB's and RCD's		✓	
1.7.3.	Torque checks on critical electrical terminations			
1.7.4.	Visual inspection all fuses		✓	
1.7.5.	Verify operation of Earth fault protection system		✓	
1.8.	**Environmental**			
1.8.1.	Vegetation management	✓	✓	✓
1.8.2.	If a weather station is present, ensure that the sensors (reference cell, Pyranometer) are in the correct location & at the correct tilt & azimuth	✓	✓	
1.8.3.	Pyranometer: Visual Check and replacement as needed of the silica gel / desiccant when colorless	✓		
1.8.4.	Visual inspection of reference cell for degradation and physical damage	✓		
1.8.5.	Visual inspection of ambient temperature sensor for degradation & physical damage	✓		
1.8.6.	Visual inspection of module temperature sensor for degradation and physical damage	✓		
1.8.7.	Visual inspection of locking mechanism, check for signs of corrosion, vandalism...etc. Spray locking mechanism with preferred lubricant	✓	✓	✓
1.9.	**Health and Safety**			
1.9.1.	Confirm that all labels are visible & not damaged	✓	✓	✓
1.10.	**Metering**			
1.10.1.	Visual Inspection of the power meters and auxiliary equipment for any anomalies including: - All meters are operating - Damage to connections		✓	
1.10.2.	Record meter readings (kWh)	✓	✓	

REF	DESCRIPTION	AFTER 4 MONTHS	BI-ANNUALY	ANNUALLY
1.11.	**Monitoring Box**			
1.11.1.	Inspect Monitoring Box for: - Tightness of connections - Water accumulation/build up - Integrity of lid seals - Integrity of cable entrance/glands - Integrity of clamping devices	✓	✓	
1.11.2.	Verify operation of CB's and RCD's		✓	
1.11.3.	Verify operation of Earth fault protection system			
1.11.4.	Visual inspection of locking mechanism, check for signs of corrosion, vandalism...etc. Spray locking mechanism with preferred lubricant		✓	✓

O & M CATEGORY

PV ARRAYS / PV MODULES / MOUNTING SYSTEM / INVERTER / WIRING CLEANING

iSolar 800- Karcher International

Water-driven brush head for photovoltaic systems

HD 10/25- 4 Cage- Karcher International

Cold water high-pressure cleaner

O & M CATEGORY

INSPECTION AND TESTING

Insulation Resistance Tester, Fluke 1507

This insulation resistance tester is a rugged, compact and reliable device. With its multiple test voltages, it is ideal for troubleshooting, preventive maintenance applications.

Visual IR Thermometer, VT04

Compact and intuitive, the VT04A and VT04 Visual IR Thermometers blend a visual image with a heat map overlay, to help quickly identify the location of issues.

Solar Installation PV 150- Seaward Solar

The PV150 is provided as part of a comprehensive test kit designed to meet all test requirements of PV systems in accordance with IEC 62446, BS EN 62446, EN 62446 and other certification schemes, standards and recommendations for best practice.

True RMS Multi-meter, Fluke 117

The Fluke 117 is the ideal meter for demanding settings like commercial buildings, hospitals and schools. The 117 includes integrated non-contact voltage detection to help get the job done faster.

Earth Resistance Tester 382252

Includes all hardware necessary to measure earth ground in 3 ranges from 20 to 2000 omega. Also tests AC/DC Voltage, resistance and continuity

Solar 300N- HT Instruments

Multifunction device for verification of single-phase and three-phase PV system efficiency and Power Quality analysis

Visual IR Thermometer VT04

The Solar AC/DC Current Clamp is a compact instrument capable of providing accurate measurements of AC or DC currents in conductors measuring up to 22mm in diameter.

MPP300- HT Instruments

An optional accessory which allows measuring and recording the main parameters which characterize single- and three phase, single and multi-string photovoltaic systems (up to three MPPT).

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HT PVCHECKS

The multifunction device PVCHECKs allows quickly and safely carrying out the electric safety tests provided for a PV system (section in DC) and the functional test of modules/strings the system consists of according to the requirements of Standard IEC/EN62446

Solar IV 1500

I-V500w allows field detection of I-V Curve an of the main characteristic parameters both of a single module and of strings of modules for PV installations up to a maximum of 1500V and 10A or 1000V and 15A

Seaward Solar Utility Pro

Test multiple strings in parallel up to 1500V 40A.
- Test at a string level or in the combiner box.
- Record up to 999 full sets of string data.
- Test open circuit voltage (Voc), short circuit current (Isc), irradiance (W/m2), ambient temperature & more.
- Free product and O&M training with every purchase

EQUIPMENT ACCESS

Ladder

Transport device for roofers and construction workers

Geda Solar Lift

The GEDA is an easy, quick and reliable transport unit for interior work, refurbishment or repairs on roof buildings. It can offer the appropriate load receptacle for any kind of building materials and any kind of use

PROPOSED PERSONNEL

Hilda Nabwile
Engineer
Bsc. Electrical Engineering

Dennis Moogi Omboga

Hillary Chesebe
Designer
Bsc Electrical Engineer

Dixon Abincha
Technician

Richard Koros
Technician

Nicodemus Mugachia
Technician

Gregory Wambua

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Maintenance Reporting

TEMPLATE

CLIENT:

DATE: May 16, 2019

PROJECT NAME: Solar Power Plant

SITE LOCATION: Nairobi, Kenya

REPORT PREPARED BY: **Nicodemus Mugachia**

DATE OF REPORTING: May 16, 2019

PROJECT IMPLEMENTATION TEAM : Nicodemus Mugachia - Technician
Dixon Abincha - Team Leader

SCOPE OF WORK: **Operation and Maintenance**

Works Carried Out

I. Insert description of activity here
ii. Insert description of activity here
iii. Insert description of activity here
iv. Insert description of activity here

Recommendations

I. Description of recommendation here.
ii. Description of recommendation here
iii. Description of recommendation here.
iv. Description of recommendation here.
Description of recommendation here
v. Description of recommendation here.

Safety Report

Recordable Safety Incidents:

Near Miss: 0

Incidents: 0

Accidents : 0

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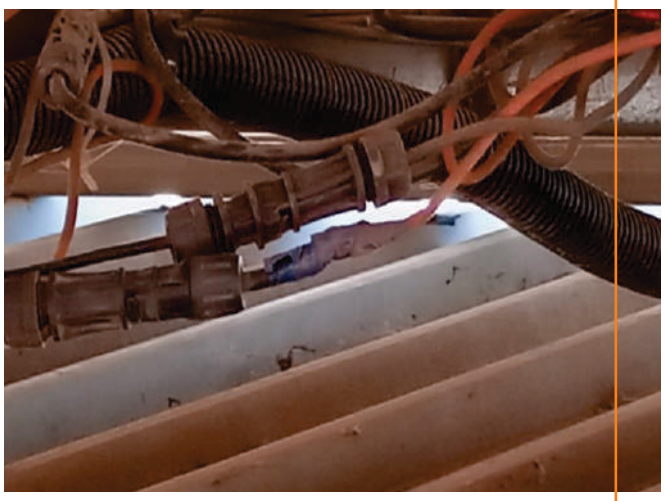
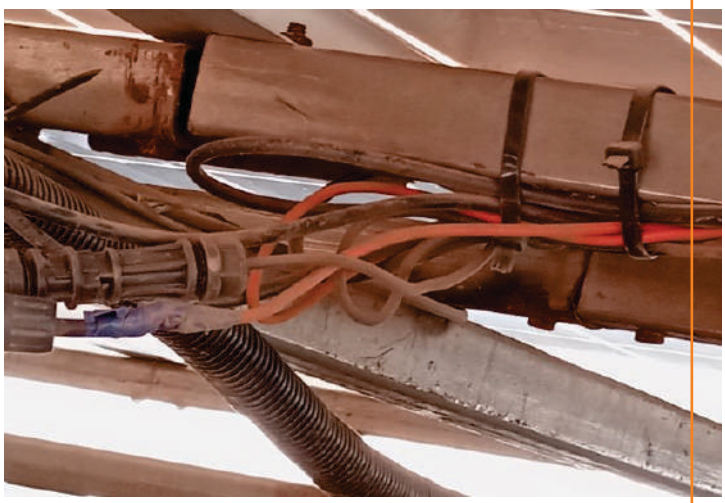


PHOTOS SHOWING SOME THE AREAS OF CONCERN



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