Technical Specifications
For 50Wp
Solar Home Systems (SHS) in the Kingdom of Cambodia

2015

PREAMBLE

The objectives of the Royal Government of Cambodia (RGC) are that by the year 2020, all the villages of the Kingdom will have electricity of some form and by the year 2030, at least 70 % of households will have access to grid-quality electricity. To assist in development of electric power in rural areas of the Kingdom of Cambodia, RGC has established a fund, by the Royal Decree No. NS/RKT/1204/048 dated 4th December 2004, called "Rural Electrification Fund" (REF). Then on August 22, 2012 RGC has issued a new Royal Decree No. NS/RKT/0812/734 on the some articles amendment of the old Royal Decree to put REF under the management of Electricité du Cambodge (EDC). Its activities are:

- To promote equitable rural electrification coverage by facilitating the population's access to electricity at affordable price for economic, social and households uses, thus contributing to its poverty reduction; and
- To promote and encourage the private sector to participate in providing sustainable rural electrification services, in particular for the exploitation of the economic application of well proven, technically and commercially, of new and renewable energy technologies (RET).

In order to promote the supply of electricity from solar energy and to manage the technical aspects of photo-voltaic modules and other Solar Home Systems (SHS) equipment, the Technical Specifications for SHS are established.

The Technical Specifications will be revised and updated by the Department of Rural Electrification Fund during the implementation period of the Project as new technology and products emerge.

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SECTION I
TECHNICAL SPECIFICATIONS

1 General

The Solar Home Systems (SHS) is intended to provide the user with a convenient means of supplying power for small electrical loads such as lights, radio/cassette players or TV. A typical SHS operates at 12Vdc and provides power for direct current fluorescent luminaries, radio/cassette players, small black and white TV or similar low-power appliances for about three to five hours a day.

The SHS is packaged and pre-wired to provide convenient installation at a remote customer home site by a qualified technician. However, in the case of fully integrated systems that are designed for set up and use by the customer ("plug and play" systems), there is no need for installation by a qualified technician. The system is constructed such that a user can perform routine maintenance such as adding battery water and replacing light bulbs and fuses, and a technician can easily perform system diagnostics or replace components.

Nominal system voltage (rated voltage) shall be 12Vdc.

The entire SHS system must be designed and constructed so that it requires maintenance and inspection by a technician no more frequently than once every 6 months.

The main components shall be integrated in such a way as to allow replacement (in case of failure) with a similarly functioning component of a newer design or a different brand. This will allow for future component evolution or variability of future component availability.

With the exception of the Photovoltaic (PV) module(s), the supplier shall design the system in such a way that many components are pre-assembled and pre-wired consistent with Section 4.2 of this document.

All components, including spares, will undergo full bench testing at the supplier factory or the originating source factory with proper documentation supplied. All set point voltages will be verified and documented with the results dated and the records maintained at the suppliers facility.

2 Applicable standards

All goods and equipment supplied under these specifications shall conform to the following standards unless otherwise specified. Other national or manufacturers' standards may be accepted under the condition that they ensure substantial equivalence or higher.

- International Electro-technical Committee (IEC) 61215: 1993 Crystalline Silicon Terrestrial PV Modules – Design Qualification and Type Approval.
- IEC 61646: 1996 Thin Film Silicon Terrestrial PV Modules – Design Qualification and Type Approval.
- IEC 60904-1: 1987 Photovoltaic Devices Part 1 – Measurement of PV Current-Voltage Characteristics.
- IEC Standard 61427 © IEC: 2001 Ed.2, Secondary Cells and Batteries for Solar Photovoltaic Energy Systems – General Requirements and Methods of Test.
- PV GAP Recommended Standards (various) See "Standards and Blank Detailed Specifications in http://www.pvgap.org for updated list.

- ASTM International E standards (E 900-2000).
- Acceptable standards for common electrical sub-items (House kit) are DIN, JIS, BS and TIS or ISO9000 series.

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អគ្គនាយកដ្ឋានអគ្គិសនីកម្ពុជា:

3 Certification Requirements

- Products to be financed under the Project must have test certificate from a testing and certification organization acceptable to the Government stating that the Solar Home Systems meets or exceeds the specifications cited in this document. Organizations accredited according to ISO 17025 or equivalent standards will be acceptable for issuing the component certification.

- Products that bear the Photovoltaic Global Approval Program (PV GAP) Mark or Seal or certified according to PVRS requirements will be acceptable for use in the Project. PV GAP is a Geneva, Switzerland-based, not-for-profit international organization, dedicated to the sustained growth of global PV markets to meet energy needs worldwide in an environmentally sound manner. For more information see http://www.pvgap.org/.

- For sub-items not bearing the PVGAP Mark or Seal, the goods or equipment to be supplied must have a type-test certificate from an accredited testing and certification organization stating that the PV System sub-item meets or exceeds the specifications. Organizations accredited according to ISO 17025:2005 *(General requirements for the competence of testing and calibration laboratories, and have those specific standards within their scope of accreditation)*, or equivalent standards will be acceptable for issuing the sub-item certifications.

- For sub-items made using same (i) production processes and construction methods, (ii) materials and (iii) quality control procedures as the certified sub-items, but are of different sizes/capacities, a Manufacturers Self Compliance Certificate if accompanied by the Certificate of the tested sub-item will be acceptable. The Manufacturers Self Compliance Certificate must be signed by an Officer of the manufacturing company and attest the following: "We confirm that the xxxxx sub-item(s) listed below have the same design and operating principles as the [state make and model number] of xxxxx sub-item that has a certificate acceptable to this project, or bears a PVGAP Mark or Seal. We further confirm that these xxxxx sub-items use the same (i) production processes and construction methods, (ii) materials and (iii) quality control procedures as the certified sub-items. [List makes and model number of xxxxx sub-items.]"

- All components, systems, documentation, and installations as appropriate, shall meet all the requirements given in this document.

4 Operating Environment

4.1 The entire system shall be designed and built to withstand the environmental conditions found in Cambodia. For design purposes, consider that temperature extremes could range from +10 to +40 degrees Centigrade and humidity levels could reach 90 percent.

4.2 All wiring, closures, and fixtures must be resistant to high humidity conditions, corrosion and insect and dust intrusion. In particular, electronic components and

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circuitry used in coastal areas subject to humid and salty conditions should have protective coatings to resist corrosion.

5 Warranty

The supplier/dealer will provide a minimum twelve-month warranty against manufacturer's defects on all parts of the PV systems (Refer section ..., Schedule of requirement, Table 1 - List of goods and Delivery Schedules: Item No. 1 to Item No. 2) and end-use devices such as light bulbs. The specific warranty conditions are further defined in Specifications A to F. The supplier/dealer will be responsible for round trip transportation charges of replacements for all parts of the PV systems (Item No. 1 to Item No. 2) and balance of system sub-items (Item No ... to Item No ...) from and to destination places as specified in the Bidding Documents (BDs).

The Supplier warrants that all the Goods are new, unused, and of the most recent or current models, and that they incorporate all recent improvements in design and materials, unless provided otherwise in the Contract. For each shipment, all warranties will start from the day the overall acceptance certificate is signed by authorized representative of the department of Rural Electrification Fund (REF) after receipt of the systems at the supplier/dealer warehouses.

On all major individual components, manufacturer's warranties will be passed through to the user. Specifically, the PV modules should be warranted against reduction of output of no more than 10 percent of rated capacity over a minimum ten year period. The charge controller, low voltage disconnect, switches, and charge indicators should be warranted for at least one year. The battery should be warranted for at least two years. Battery end-of-life will be determined when the battery capacity down 1.75 V/cell at 25 degrees centigrade drops to less than 80 percent of the initial rated capacity. The warranty period of SHS to the user is started from the date of installation agreement between user and EDC. The supplier will deal the warranty work until finish warranty period of the contract.

6 Packaging and Transportation

The following instructions on packaging and transportation apply for each item before shipping to final destination in Cambodia, and based on the quantities indicated in list of good and delivery schedule.

1. Each item shall be properly packaged for shipping to prevent any shipping related damage. The bidder will be responsible for settling any shipping related damage claims up to the supplier/dealer warehouses and will be responsible for replacing damaged sub-items in a timely manner.
2. One complete pre-wired battery box for each system must be packaged together with two lamps, two holders and two reflectors in a box. The solar modules for each system should be conveniently packaged in separate boxes. The remaining lamps, holders and reflectors shall be appropriately packaged, the quantity per final destination being in accordance with the list of good and delivery schedule.
3. The bidder must keep in mind that most of goods have to be shipped to their rural destination on roads/tracks, which are in poor conditions. Packing box labels, sizes and weights should be appropriate for manual handling in rural areas by no more than two persons per item.
4. A Packing List shall be attached to the outside of each box so as to be clearly readable and accessible for scanning with a bar code reader.

This list shall include the following:

a) quantity and description of each item of contents (including major internal sub-items, such as battery and controller inside the battery box);
b) serial number of each item of contents; and
c) Bar code of the serial number of each item of contents.

I Specification A: Solar Photovoltaic Modules

1. The photovoltaic array will consist of one or more flat-plate photovoltaic modules. Each module should comprise of no less than 36 series-connected single or poly-crystalline silicon solar cells. Flat plate thin-film modules could also be used.
2. Cells should be laminated between high transmissivity low iron tempered glass and weather resistant back-sheet to protect moisture penetration.
3. The photovoltaic module should have a peak power output of at least the specified rated value respectively under Standard Test Conditions (STC) as defined in IEC 60904-1. The peak power output for thin film modules should be the value after light soaking.
4. PV modules that bear the PV GAP Mark as proof of compliance with PVRS2 or PVRS3 will be accepted. In the absence of a PV Mark or Seal, modules must be certified in accordance with IEC 61215, IEC 61646 or IEE Specification 1262-1995 and must be manufactured in an ISO 9000 accredited manufacturing facility. For photovoltaic modules of differing sizes made by the same manufacturer, and use the same (i) production processes and construction methods, (ii) materials and (iii) quality control procedures as previously certified module, a Manufacturer's Self Compliance Certificate will be accepted in lieu of the above certifications. Each module must be factory equipped with either (a) weather-proof junction box with terminal strip that allows safe and long lasting wiring connection to the module, or (b) output cable that connects the module via a sealed weather proof termination.
5. Each module should have a permanent label fixed by manufacturer, printed in indelible manner such that it can be reasonably expected to remain legible for 10-15 years when used in remote tropical areas, carrying the following minimum information: Manufacturers name and location, type and model number, Serial Number, Bar Code of the serial number, Peak Watts, I_{sc}, I_{max}, V_{max}, V_{oc} (at 1000W/m^2 irradiance at 25°C cell temperature and 1.5 AM) and certification mark or description.
6. The supplier's name should be added on a separate label with contact information (such as land and email addresses) and order date, to assist with warranty inquiries.
7. The modules must be constructed with heavy duty anodized aluminum frames tough enough to protect the modules from damage during use and during transport over rough terrain, and suitable for drilling and bolting for support brackets. Four movable holes will be drilled in the frames to fix the panel to the supporting frame.
8. Four holes will be drilled in the frames to fix the panel to the supporting frame. The supplier will provide 5 galvanized bolts + nuts (6 mm diameter and 20 mm long) per system (four + one spare).
9. PV module support structure with aluminum pole make mounting PV module on the roof top attached with silicon water proof.

Warranty: The modules should be warranted against reduction of output of no more than 10% of rated capacity over a ten-year period.

II Specification B: Charge Controllers (12Vdc)

1. Controllers that bear the PVGAP mark attesting to meeting PVGAP PVRS6A and meet the Pulse Width Modulated (PWM) requirement noted in item 2 below will be accepted without further certifications. For controllers that do not meet this requirement, a certificate issued by a testing laboratory accredited to ISO 17025 requirements, attesting that the controllers have been tested and meet the requirements noted below, should be provided.
2. The charge controller set points must be factory preset with the set points applicable to the specified battery characteristics to prevent battery over-charge (high-voltage-disconnect and reconnect set points) or over-discharge (low-voltage-disconnect and reconnect set points). Controller shall be series design, not shunt. Controller shall be constant voltage Pulse Width Modulated (PWM) charging with 0-100% duty cycle. On/off style switching controllers are not acceptable. Circuitry to allow periodic equalizing charging of the battery must be provided. Control set points for charging, discharging and other functions must be sufficiently stable to insure proper operation of the device over the range of anticipated ambient temperatures (0°C to +50°C).
3. The charge controllers' nominal currents must be 5A for the 50Wp system.
4. The charge controller must be able to withstand 125% of the PV module rated open circuit voltage with the battery removed from the circuit for one hour duration.
5. The low voltage disconnect must be capable of handling at least 150 percent of the maximum expected continuous load (assuming all end use devices are on simultaneously).
6. Maximum current draw of the controller, when no LED's are lit should not exceed 10 mA.
7. Controller should include the following protective features:

    a. Electronic fuses should be self-resetting or resettable. Mechanical fuses are not acceptable.
    b. Lightning surge protection.
    c. The quiescent current consumption should not be more than 8mA.
    d. Use of electro-mechanical relays is not permitted.
    e. Protection against short circuit of PV, load and battery connections.
    f. Protection against reverse polarity for both PV and battery connections.
    g. Reverse current leakage protection must be provided.
    h. High voltage load protection to 125% of rated battery voltage.
    i. Sealant of both sides of circuit board to prevent corrosion.

8. Some means must be provided to safely disconnect the battery and the module during servicing or repair by a technician.
9. Each Controller should have a permanent label fixed by manufacturer, printed in indelible manner such that it can be reasonably expected to remain legible for at least 5 years when used in remote tropical areas, carrying the following minimum information:

    a. Make and Model Number,
    b. Serial Number,
    c. Bar Code (containing the serial number),
    d. Nominal Voltage [V],
    e. Maximum PV- Current [A],
    f. Maximum Load Current [A],
    g. Polarity of Terminals,
    h. Displays,

i. Characteristic Fuse Rating.

Warranty: The Charge Controllers must be warranted against failure for a minimum of 2 years.

III Specification C: Batteries (12Vdc)

1. The battery will be sealed Valve Regulated Lead Acid (VRLA) and Absorbed Glass Mat (AGM) type, either of flat or tubular plate.
2. Batteries that bear the PVGAP mark attesting to meeting PVGAP PVRS5A will be accepted without further certifications. For batteries that do not meet this requirement, a certificate issued by a testing laboratory accredited to ISO 17025 requirements, attesting that the batteries have been tested and meets the requirements noted below, should be provided.
3. The nominal capacity value of the batteries should be C/20 discharge (specified at 25°C and at 20h discharge rate down to 1.75V per cell)
4. Battery cycle life must exceed 1000 cycles at 10% daily depth-of-discharge (DOD), and 200 cycles at 50% DOD, at 25°C.
5. Battery end-of-life will be determined when the battery capacity down to 1.75 V/cell at 25°C drops to less than 80 % of the initial rated capacity.
6. The maximum self-discharge should not exceed 5% of their rated capacity per month.
7. The batteries should satisfactorily withstand the interim battery capacity test noted in Section IV (Page 15 to 17), with the following acceptance criteria: The battery capacity should be at least 100% of the nominal capacity C10 capacity after the "6th C10-test".
8. For a flat plate battery, after it has gone through 3 test sequences according to IEC Standard 61427 IEC:2001 Ed.2 "Secondary Cells and Batteries for Solar Photovoltaic Energy Systems – General Requirements and Methods of Test" (a test sequence is defined as going through one complete procedure defined in paragraphs 6.4.1, 6.4.2 and 6.4.3 of IEC 61427), the battery should yet retain at 80 percent of its initial C10 capacity (according to end-of-test condition as defined in paragraph 6.4.4. Similarly, for tubular plate battery, after it has went through 8 test sequences as defined above, the battery should yet retain at least 80 percent of its initial C10 capacity according to test procedures given in draft IEC Standard 61427 standard.
9. Each Battery should have a permanent label fixed by manufacturer, printed in indelible manner such that it can be reasonably expected to remain legible for at least 5 years when used in remote tropical areas, carrying the following minimum information:

    a. Make and Model,
    b. Nominal Capacity (20 hour rate),
    c. Date of Production engraved,
    d. Polarity of Terminals,
    e. Bar Code (containing the serial number).

Warranty: The batteries must be warranted against failure for a minimum of 2 years.

IV Specification D: Lamps (12Vdc)

1. The lamps will be 12V 3W DC energy saving LED Bulb Light (LED) of E27 screw type base.
2. Each lamp should be provided with a reflector and a holder that can be installed from the ceiling or attached to the wall.

3. Lamps should be resistant to insects, corrosion and moisture.
4. Lens covers if used, should be easily removable by user for bulb replacement and cleaning. The design of the lamp must allow for tube replacement without risk to the user of coming in contact with any electrical component or contacts that could injure the user or damage the fixture.
5. LED Bulb Light that bear the PVGAP mark attesting to meeting PVGAP-PVRS7 A will be accepted without further certifications so long as luminous efficacy should be at least 100 lumen/rated Watt (rated voltage times rated current of the lamp and not the rating of tube and without any covers or reflectors). For LED Bulb Light that do not meet This requirement, a certificate issued by a testing laboratory accredited to ISO17025 requirements, attesting that the lamps have been tested and meets the requirements noted below, should be provided.
6. The minimum operating frequency should be greater than 20 kHz.
7. The generated wave shape must be symmetrical in both half cycles over the voltage range of 10 to 14Vdc at an ambient temperature of 25°C.
8. The input connections to the inverter should prevent the application of voltage with reverse polarity, or the inverter should be protected against damage when the rated voltage is applied with reverse polarity.
9. The lifetime of LED Bulb Light must exceed 30,000 hours.
10. LED Bulb Light must be marked with the manufacturer name; model number, rated voltage, wattage and date of manufacture or batch number.

Warranty: The lamps must be warranted against failure for a minimum of 1 year.

V Specification E: House Kit Sub-items

1. The 230/400V conductor should be stranded, except the conducts from charge controller to all other loads are single copper wires, and flexible insulated copper, twin core sheathed and insulated to withstand circuit voltage of 1000V and conductor temperature of 70°C must be used. All wiring shall be color coded and/or labeled.
2. Minimum acceptable cross section of the wire in each of the following sub-circuits is as follows:

   - From PV module to Charge Controller: 2 x 4 mm²
   - From Charge Controller to Battery: 2 x 2.5 mm²
   - From Charge Controller to socket outlet: 2 x 2.5 mm²
   - From Charge Controller to all other loads: 2 x 1 mm²

3. The 2x4 mm² conductors for outdoor use should be sheathed with a UV protective material according to IEC 60811, H07RNF or equivalent standard. Alternative of protection inside a UV-resistant conduit is also accepted.
4. All house kit sub-items should be of quality approved by the national industrial standards of the country of origin. Acceptable standards are DIN, JIS, BS and TIS or ISO9000 series.
5. Tumbler switches as well as sockets and plugs should be DC-rated to be able to carry currents of up to 5A at 12Vdc. If AC sub-items are used the current ratings should be at least 15A at 230VAC.
6. The plug and sockets should physically prevent reverse polarity connections.
7. Tumbler switches as well as sockets and plugs should be included their support box. The supplier will provide screws for support box; minimum 4 screws for fixing each socket and/or plug into the wood wall.

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VI Specification F: Battery Boxes (DC Power Supply Board)

1. The battery and charge controllers are to be wired and assembled in a compact durable box constructed of non-corrosive material such as PVC or other heavy duty plastic. If metal containers are used it must be coated with material that will prevent corrosion from acid spills and humidity. The enclosure must be constructed of a durable material so as to last 10 years without maintenance.
2. The front side of the box should have indicators and a resettable circuit breaker for overload.
3. One lateral side must be equipped with one input socket for PV module. The other lateral side must be equipped with one output socket for loads. The outlet will be protected by the circuit breaker. In addition, two adapted male plugs will be provided with the battery box to be installed by the local technician.
4. The indicators may be LED's, LCDs, or analog or digital meters, and must, at a minimum, indicate when the PV system condition is:

   - Charging mode.
   - Battery state of charge.
   - Pre-warning of low voltage disconnects (LVD).

5. The chosen indicator must come appropriately labeled such that the user does not have to refer to a manual to understand the existing battery or PV module condition.
6. The inlet socket for the PV module mounted on the battery box must be designed to prevent reverse-polarity connection, and also to prevent connection of any other type of device (i.e. use of any standard household sockets and plugs is not allowed). A matching connection plug, compatible with the PV module inlet socket and PV module inlet cable specified in the House Kit sub-items must be supplied. This plug will be fitted to the module inlet cable by trained technicians in the field during installation. These sockets and plugs must be DC rated and capable of carrying up to 5A at 12Vdc for the 50Wp system.

   The inlet socket must be clearly labeled with intuitive icons depicting a solar panel and/or the sun.

7. The outlet socket for the loads mounted on one lateral side of the battery box must be connected to the charge controller outlet and designed to prevent reverse-polarity connection, and also to prevent connection of any other type of device (i.e. use of any standard household sockets and plugs is not allowed). A matching connection plug, compatible with the load outlet socket and load outlet cable specified in the House Kit sub-items must be supplied. This plug will be fitted to the load outlet cable by trained technicians in the field during installation. These sockets and plugs must be DC rated and capable of carrying up to 5A at 12Vdc for the 50Wp system.

   The outlet sockets for loads must be clearly labeled with intuitive icons depicting a small generic household appliance (e.g. lamp and portable radio).

8. The resettable circuit breaker (single pole) for protecting the battery and controllers from defects caused by overload should be installed between controller and outlet sockets and should be rated 12Vdc and current of 5A for 50Wp system.

The circuit breaker should be resettable by the user once the overload is disconnected. This circuit breaker must be clearly labeled with instructions in Khmer Language not to use heavy loads.

9. The battery and controller shall be assembled in such a way as to allow replacement (in case of failure) by a trained field technician at the installation site, with a similarly functioning sub-item, of a newer design or a different brand. This will allow for future sub-item evolution or variability of future sub-item availability. Units that are only factory serviceable will not be accepted.
10. None of the electrical connections or terminals (controller, battery, plugs, sockets, fuses …) should be accessible to users. Switches, inlet/outlet plug and/or sockets and protection fuse reset buttons (if used) should be user accessible.
11. The DC power supply board must be properly vented to allow heat dissipation and/or gas emission.
12. The DC power supply board must also be equipped with simple but strong and reliable features on the back side enabling the installers to solidly tie the box to any structure inside the house.
13. The suggested design of the DC power supply board is summarized on the following page.

Warranty: The DC power supply board shall be warranted against failure for 5 years and the warranty conditions shall allow trained technicians to open the DC power supply board in the field and perform routine troubleshooting and maintenance including replacement of the battery and/or controller.

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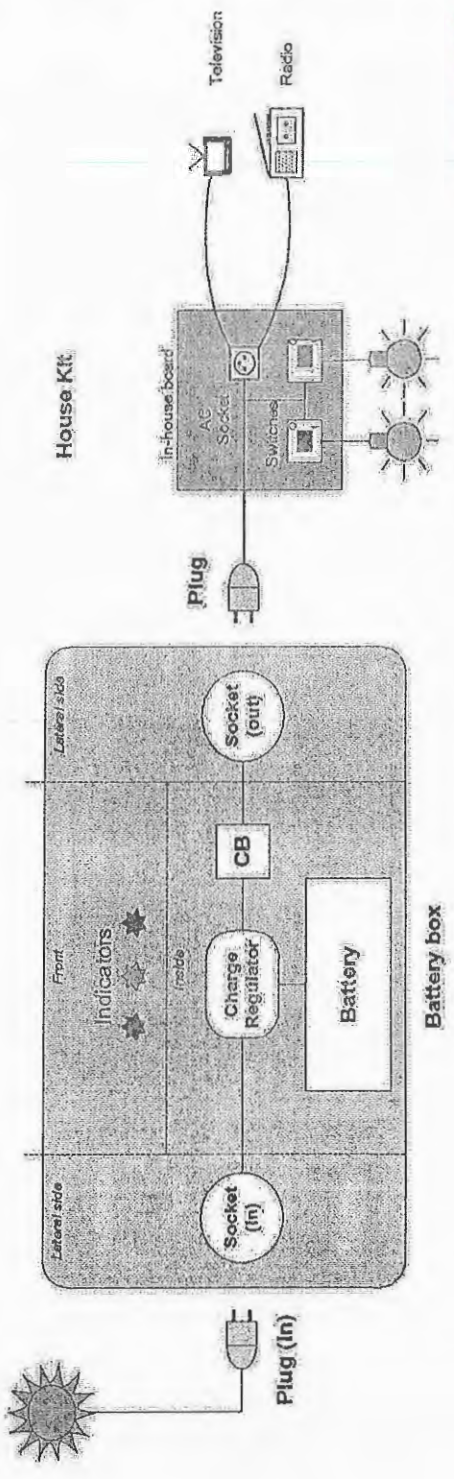
Schematic Representation of the SHS[1]



[1] This drawing is given to illustrate the principle of the solar home systems. For specifications and quantity of goods, please refer to the text.

SECTION II
DRAWINGS AND DOCUMENTATION

The bidders must submit the following:

Drawings:

a. Mechanical drawings showing detailed physical specifications for Item No. 1 and Item No. 2. As specified in section …, Schedule of Requirements, Table1 -List of Good and Schedule.

b. Mechanical drawings showing detailed physical specifications for all PV modules for Item No. 1 and Item No. 2. As specified in section ..., Schedule of Requirements, Table 1-List of Goods and Schedule.

c. Mechanical drawings showing detailed physical specifications of the battery and controller box.

d. A circuit diagram showing the wiring connections of sub-items assembled in the battery box.

Documentation:

The PV systems must be provided with two supporting documents, namely, a **User's Manual** intended for the customers (to be included with each of the packaged systems) and a **Technician's Manual for Installation, Operations and Maintenance** (for use by the service technicians). The latter will include the specific details on installation, operation and maintenance. The documents must be provided in English with permission to translate into local language. The User's Manual documentation should be simple and easy to understand. Sketches and graphics should be provided to make the manual easy to understand and use. The documentation shall include the following:

1. Theory of operation with a discussion on: battery charging by the array; functions, battery low voltage protection and battery overcharge protection. The relationship between energy available on a daily basis and sunlight conditions should be clearly and simply explained.
2. A description of all user interactive hardware including disconnect switches and status indicators.
3. Procedures for proper system operation, including a list of load limitations and any problem loads. Suggested operation, including load conservation during periods of inclement weather and/or a low voltage disconnect event. The procedures for checking that the photovoltaic array is not shaded and how to prevent shading must be explained.
4. Any user maintenance items.
5. Procedures for emergency shut down and for extended periods of system non-use.
6. A trouble-shooting guide for users.

1. A complete list of all system sub-items, with associated manufacturers literature, specifications and warranties.
2. Complete installation instructions.
3. A recommended post-installation acceptance test procedures, including all appropriate set points and test procedures. They will include the following:

   - Verify that the installation of the photovoltaic module with regard to position, direction, inclination and shading avoidance will maximize energy generation.
   - Ensure that the battery has received an equalization charge just before installation.
   - Use a shunt to measure the current from the array under charging conditions to verify the array charging current. This measurement should be done under clear sky conditions.
   - Test all the loads for proper operation.
   - Make system-wide voltage drop measurements in the sub-circuits to verify that connections are within the maximum allowable voltage drop.
   - Note all measurements in the installation log.
   - Explain to the user the system operating principles, load management requirements, impact of shading of the array and how to check and avoid it, user maintenance checks and how to conduct them.

4. A recommended annual maintenance schedule, with complete maintenance instructions.
5. A detailed trouble-shooting guide referencing all the system sub-items. This shall include repairs and diagnostic procedures that can be done by the supplier or a qualified third party. Repairs and procedures not to be attempted by non-electricians and/or electricians unfamiliar with photovoltaic systems shall also be identified.
6. A functional block diagram, electrical single-line drawing showing the placement of all hardware and ratings of all sub-items and physical layout diagram.
7. Emergency shutdown procedures.
8. Product Service Manuals for the controllers, batteries, PV modules and lamps.

Note: The supplier must also provide electronic copies of all above documents (**User's Manual and Technician's Manual for Installation, Operations and Maintenance**) in Khmer language.

SECTION III
INSPECTIONS AND TESTS

The following inspections and tests shall be performed:

I General Condition

1. Sub-items must be tested and certified according to specified standards or performance specifications at a testing center that is accredited to ISO 17025 requirements to perform such tests.
2. All sub-items, including spares, will undergo full bench testing at the supplier factory or the originating source factory with proper documentation supplied. All set point voltages will be verified and documented with the results dated and the records maintained at the suppliers facility.
3. The supplier is to deliver random samples of the equipment taken from the production line, for physical inspection and electricity performance tests by the purchaser.
4. The purchaser reserves right to reject any Goods or any part thereof that fails to pass any test and/or inspection or do not conform to the specifications. The Supplier shall either rectify or replace such rejected Goods or parts thereof or make alterations necessary to meet the specifications at no cost to the Purchaser, and shall repeat the test and/or inspection, at no cost to the Purchaser
5. Each sub-item delivered should bear a permanent label with serial numbers plus measured detailed electrical specifications as indicated in the Specifications.

II Training

The bidder shall organize o training workshop in Cambodia on the use and testing of Solar Home System (SHS) in consultation with Department of REF.

SECTION IV
INTERIM BATTERY ACCEPTANCE SHORT TEST PROCEDURE

Perform the test sequence as given below in Table 1 while maintaining the battery temperature between 20-25°C[2]. The tests must be conducted on 3 batteries that are randomly selected, at a testing center acceptable to the PMO. Record the data in Table 2. If the test results vary by more than 10% of each other, for the three batteries, an additional two batteries should be tested to achieve better statistical significance. This test will take approximately 17 days to perform using automatic battery testing equipment.

Table 1 Interim Battery Acceptance Short Test Procedure

Capacity Test No.	Step	Current/voltage Setting	Current/voltage Limit	End-of-step Criteria	Remarks
	Initial charge	$+I_{10}$		U=2.4 V/cell	Constant current charging
	Initial charge	2.4 V/cell	$+I_{10}$	Duration 8 hours	Constant voltage charging.
1. C10 Test	1st discharge	$-I_{10}$		U<1.8 V/cell	
	Rest Period	0 A		I hour	Battery on open circuit
	1st recharge	$+I_{10}$		U=2.4 V/cell	Constant current charging
	1st recharge	2.4 V/cell	$+I_{10}$	Duration 8 hours	Constant voltage charging.
2. C10 Test	2nd discharge	$-I_{10}$		U<1.8 V/cell	
	Rest Period	0 A		I hour	Battery on open circuit
	2nd recharge	$+I_{10}$		U=2.4 V/cell	Constant current charging
	2nd recharge	2.4 V/cell	$+I_{10}$	Duration 8 hours	Constant voltage charging
3. C10 Test	3rd discharge	$-I_{10}$		U<1.8 V/cell	
	Rest Period	0 A		I hour	Battery on open circuit
	3rd recharge	$+I_{10}$		U=2.4 V/cell	Constant current charging
	3rd recharge	2.4 V/cell	$+I_{10}$	Duration 8 hours	Constant voltage charging

[2] Depending on the battery temperature (or ambient temperature in the laboratory during the tests) a correction of the capacity is necessary if the temperature deviates by more than 3 deg Kelvin from 25°C. A correction factor of 0.6% per Kelvin is commonly used (see formula below). The formula can be applied for temperatures between 10 and 35°C. The pass criteria must be fulfilled for the temperature corrected values.

$$C_{10}^{25°C} = \frac{C_{10}^{T_{measured}}}{1+0.006\cdot(T_{measured}-25°C)}$$

Table 1 Interim Battery Acceptance Short Test Procedure					
Capacity Test No.	**Step**	**Current/voltage Setting**	**Current/voltage Limit**	**End-of-step Criteria**	**Remarks**
4. C10 Test	4th discharge	$-I_{10}$		U<1.8 V/cell	
	4th recharge	$+ I_{10}$		U=2.4 V/cell	Constant current charging
	4th recharge	2.4 V/cell	$+ I_{10}$	Gradient of current is 0 A/s, but maximum 36 hours [3]	Constant voltage charging
Alternative for 4th recharge depending on availability of equipment					
	4th recharge	*$+ I_{10}$*		*U=2.4 V/cell*	*Constant current charging*
	4th recharge	*2.4 V/cell*	*$+ I_{10}$*	*$I < 0.1 \times I_{10}$*	*Constant voltage charging*
	4th recharge	*$0.1 \times I_{10}$*		*Capacity charged in 4th recharge > 112% of capacity discharged during 4th discharge*	
5. C_{10} Test	5th discharge	$-I_{10}$		U<1.8 V/cell	
	Rest Period	0 A		I hour	Battery on open circuit
	5th recharge	$+ I_{10}$		U=2.4 V/cell	Constant current charging
	5th recharge	2.4 V/cell	$+ I_{10}$	Duration 8 hours	Constant voltage charging
	6. C_{20} discharge	$-0.5 \times I_{10}$		U< 1.8 V/cell	
	Rest Period	0 A		I hour	Battery on open circuit
	6th recharge	$+ I_{10}$		U=2.4 V/cell	Constant current charging
	6th recharge	2.4 V/cell	$+ I_{10}$	Duration 8 hours	Constant voltage charging
	7. C_{100} discharge	$-0.1 \times I_{10}$		U< 1.8 V/cell	
	Rest Period	0 A		I hour	Battery on open circuit
	7th recharge	$+ I_{10}$		U=2.4 V/cell	Constant current charging
	7th recharge	2.4 V/cell	$+ I_{10}$	Duration 8 hours	Constant voltage charging
	8. C_5 discharge	$-2 \times I_{10}$		U< 1.8 V/cell	
	Rest Period	0 A		I hour	Battery on open circuit
	8th recharge	$+ I_{10}$		U=2.4 V/cell	Constant current charging

[3] Note that the end of the constant voltage charging is reached only when the battery current has not changed for two hours. If this criterion has not been reached after 36 hours of the charging process, continue with the next step of the test procedure.

Table 1 Interim Battery Acceptance Short Test Procedure					
Capacity Test No.	**Step**	**Current/voltage Setting**	**Current/voltage Limit**	**End-of-step Criteria**	**Remarks**
	8^{th} recharge	2.4 V/cell	$+ I_{10}$	Duration 8 hours	Constant voltage charging
6. C_{10} Test	9^{th} discharge	$- I_{10}$		U< 1.8 V/cell	
	Rest Period	0 A		1 hour	Battery on open circuit
	9^{th} recharge	$+ I_{10}$		U=2.4 V/cell	Constant current charging
	9^{th} recharge	2.4 V/cell	$+ I_{10}$	Duration 8 hours	Constant voltage charging

Table 2 Data Recording for Interim Battery Acceptance Short Test					
Discharge Capacity Test	**Discharging Current (A)**	**End-of-Discharge Voltage (V/cell)**	**Battery Temperature (°C)**	**Measured Capacity (Corrected to 25°C (Ah))**	**Pass Criteria**
1. C_{10} Test	$1 \times I_{10}$ =	1.80			
2. C_{10} Test	$1 \times I_{10}$ =	1.80			
3. C_{10} Test	$1 \times I_{10}$ =	1.80			
4. C_{10} Test	$1 \times I_{10}$ =	1.80			
5. C_{10} Test	$1 \times I_{10}$ =	1.80			Measure Capacity ≥ 100% Nominal Capacity
C_{20} Test	$0.5 \times I_{10}$ =	1.80			
C_{100} Test	$0.1 \times I_{10}$ =	1.80			
C_5 Test	$2 \times I_{10}$ =	1.70			
6. C_{10} Test	$1 \times I_{10}$ =	1.80			Measured Capacity ≥ 95% Nominal Capacity

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អគ្គនាយកដ្ឋានលទ្ធកម្មសាធារណៈ

Technical Specifications
For 5Wp
Solar Home Systems
in the Kingdom of Cambodia

2015

PREAMBLE

The objectives of the Royal Government of Cambodia (RGC) are that by the year 2020, all the villages of The Kingdom will have electricity of some form and by the year 2030, at least 70 % of households will have access to grid-quality electricity.

To assist in development of electric power in rural areas of the Kingdom of Cambodia, RGC has established a fund, by the Royal Decree No. NS/RKT/1204/048 dated 4th December 2004, called "Rural Electrification Fund" (REF).

Then on August 22, 2012 RGC has issued a new Royal Decree No. NS/RKT/0812/734 on the some articles amendment of the old Royal Decree to Put REF under the management of Electricité du Cambodge (EDC). Its activities are:

- To promote equitable rural electrification coverage by facilitating the Population's access to electricity at affordable price for economic, social and Households uses, thus contributing to its poverty reduction; and
- To promote and encourage the private sector to participate in providing Sustainable rural electrification services, in particular for the exploitation of the Economic application of well proven, technically and commercially, of new and Renewable energy technologies (RET).

In order to promote the supply of electricity from solar energy and to manage the Technical aspects of Photo-voltaic modules and other 5Wp Solar Home Systems (SHS) Equipment, the Technical Specifications for 5Wp SHS are established.

The Technical Specifications will be revised and updated by the Department of Rural Electrification Fund during the implementation period of the Project as new technology and products emerge.

SECTION I
TECHNICAL SPECIFICATIONS PICO SOLAR HOME SYSTEMS (PSHS)

1. General

A Pico Solar Home System (PSHS) which is included the Portable Solar Lamp (PSL) is defined as a small PV-system with a power output of 1 to 10W, mainly used for lighting, Portable lantern, Phone charger and thus able to replace unhealthy and inefficient sources such as kerosene lamps and candles.

Nominal system voltage (rated voltage) shall be 3.7 Vdc.

Depending on the model, small ICT applications (e.g. mobile phone charger, radio) can also be added. 5Wp SHS are powered by a small solar panel and use a battery which can be integrated in the lamp itself.

2. Advantages of PSHS

5Wp SHS offer a wide range of advantages:

- There is no need for installation by a qualified technician. 5Wp SHS is a fully integrated system that is designed for set up and use by the Customer ("plug and play" systems).
- Little maintenance required high degree of expandability and flexible use.
- The prices are general. It is within the payment capacity of most rural people in developing Countries.

3. Applications

5Wp SHS offer a variety of using purposes:

- **Outdoor:** Camping, hiking, fishing, hunting, boating, Earthquake and hurricane emergency power kits…etc.
- **Indoor:** Home lighting in rural regions where the power supply is irregular and scarce or in the urban as backup lighting during power cuts.
- Charger: Charging mobile phones, PDA,GPS, MP3/MP4… etc. (with optional cable and connectors)

SECTION II
GENERAL REQUIREMENTS

1. Applicable Standards

All goods and equipment supplied under these specifications shall conform to the following standards unless otherwise specified. Other national or manufacturers' Standards may be accepted under the condition that they ensure substantial equivalence or higher.

- International Electro-technical Committee (IEC) 61215: 1993 Crystalline Silicon Terrestrial PV Modules - Design Qualification and Type Approval.
- IEC 61646: 1996 Thin Film Silicon Terrestrial PV Modules – Design Qualification find Type Approval.
- IEC 60904-1: 1987 Photovoltaic Devices Part 1 - Measurement of PV Current-Voltage Characteristics.
- IEC Standard 61427 © IEC: 2001 Ed.2, Secondary Cells and Batteries for Solar Photovoltaic Energy Systems - General Requirements and Methods of Test.
- PV GAP Recommended Standards (various) See "Standards and Blank Detailed Specifications in http://www.pvgap.org for updated list.
- ASTM International E standards (E 900-2000).
- Acceptable standards for common electrical sub-items (House kit) are DIN, JIS, BS and TIS or IS09000 series.

2. Certification Requirements

- Products to be financed under the Project must have test certificate from a testing and certification organization acceptable to the Government stating that the 5Wp SHS meets or exceeds the specifications cited in this document. Organizations accredited according to ISO 1702S or equivalent standards will be acceptable for issuing the component certification.
- Products that bear the Photovoltaic Global Approval Program (PV GAP) Mark or Seal or certified according to PVRS requirements will be acceptable for use in the Project. PV GAP is a Geneva, Switzerland-based, not-for-profit international organization, dedicated to the sustained growth of global PV markets to meet energy needs worldwide in an environmentally sound manner. For more information see http://www.pvgap.org/.
- For sub-items not bearing the PVGAP Mark or Seal, the goods or equipment to be supplied must have a type-test certificate from an accredited testing and certification organization stating that the PV System sub-item meets or exceeds the specifications. Organizations accredited according to ISO*17025:2005 (General requirements for the competence of testing and calibration laboratories, and have those specific standards within their scope of accreditation),* or equivalent standards will be acceptable for issuing the sub-item certifications.
- For sub-items made using same (i) production processes and construction methods, (ii) materials and (iii) quality control procedures as the certified sub-items, but are of different sizes/capacities, a Manufacturers Self Compliance Certificate if accompanied by the Certificate of the tested sub-item will be acceptable. The Manufacturers Self Compliance Certificate must be signed by an Officer of the manufacturing company and attest the following: "We confirm that the xxxxx sub-item(s) listed below have the same design and operating principles as the [state make and model number] of xxxxx sub-item that has a certificate acceptable to this project, or bears a PVGAP Mark or Seal. We further confirm that these xxxxx sub-

items use the same (i) production processes and construction methods, (ii) materials and (iii) quality control procedures as the certified sub-items. [List makes and model number of xxxxx Sub-items.]"

- All components, systems, documentation, and installations as appropriate, shall meet all the requirements given in this document.

3. Operating Environment

- The entire system shall be designed and built to withstand the environmental conditions found in Cambodia. For design purposes, consider that temperature extremes could range from +10 to +40 degrees Centigrade and humidity levels could reach 90 percent.
- All wiring, closures, and fixtures must be resistant to high humidity conditions, corrosion and insect and dust intrusion. In particular, electronic components and circuitry used in coastal areas subject to humid and salty conditions should have protective coatings to resist corrosion.

4. Warranty

The supplier/dealer will provide a minimum twelve-month warranty against manufacturer's defects on all parts of the PV systems. The warranty period twelve-month to the user will start from the date of installation agreement between user and EDC/REF. The supplier will deal the warranty work until finish warranty period of the contract.

The specific warranty conditions are further Defined in Specifications A to G. The supplier/ dealer will be responsible for round trip Transportation charges of replacements for all parts of the PV systems (Item No.1 to Item No.2) and balance of system sub-items (Item No ... to Item No ...) from and to destination places as specified in the Bidding Documents (BOs).

The Supplier warrants that all the Goods are new, unused, and of the most recent or current models, and that they incorporate all recent improvements in design and materials, unless provided otherwise in the Contract.

On all major individual components, manufacturer's warranties will be passed through to the user. Specifically, the PV modules should be warranted against reduction of output of no more than 10 percent of rated capacity over a minimum ten year period. The chargecontroller, low voltage disconnect, switches, and charge indicators should be warrantedfor at least one year. The battery should be warranted for at least two years. Battery end-of-life will be determined when the battery capacity down 1.75 V/cell at 25 degreescentigrade drops to less than 80 percent of the initial rated capacity.

5. Packaging and Transportation

The following instructions on packaging and transportation apply for each item before shipping to final destination in Cambodia, and based on the quantities indicated in list of good and delivery schedule.

- Each item shall be properly packaged for shipping to prevent any shipping relateddamage. The bidder will be responsible for settling any shipping related damage claims up to thesupplier/dealer warehouses and will be responsible for replacingdamaged sub-items in a timely manner.

- The bidder must keep in mind that most of goods have to be shipped to their ruraldestination on roads/tracks, which are in poor conditions. Packing box labels, sizesand weights should be appropriate for manual handling in rural areas by no morethan two persons per item.
- A Packing List shall be attached to the outside of each box so as to be clearly readable and accessible for scanning with a bar code reader.

6. Product Components

The products should be composed with PSHS together with PSL to be supplied at the same time and should consist of the following components.

- 1 pcs of solar photovoltaic module.
- 1 pcs of "plug-and-play" system unit (Battery, Charge Controller, Protection Circuit…etc).
- 1 set of kit for wall mounting of the System Unit of PSHS.
- 2 pcs of Lighting Source (Cable, Lamp, Plug…etc).
- 1 set of Phone charger with set of adapters.
- 1pcs of Portable Solar Lamp (Lantern).
- 1 manual in Khmer.

SECTION III
DETAIL TECHINICAL SPECIFICATIONS OF PSHS
AND ITS COMPONENT (PSL)

1. Specification A: Solar Photovoltaic Modules

- The Module should be 5W/ 6V Poly-Crystalline solar panel.
- The efficiency of the solar panel should be over 17%.
- The photovoltaic array will consist of one or more flat-plate photovoltaic modules.
- Cells should be laminated between high transmissivity low iron tempered glass and weather resistant back-sheet to protect moisture penetration.
- The photovoltaic module should have a peak power output of at least the specified rated value respectively under Standard Test Conditions (STC) as defined in IEC0904-1. The peak power output for thin film modules should be the value after light soaking.
- PV modules that bear the PV GAP Mark as proof of compliance with PVRS2 or PVRS3 will be accepted. In the absence of a PV Mark or Seal, modules must be certified in accordance with IEC 61215, IEC 61646 or IEE Specification 1262-1995 and must be manufactured in an ISO 9000 accredited manufacturing facility.
- The modules must be constructed with heavy duty anodized aluminum frames tough enough to protect the modules from damage during use and during transport over rough terrain, and suitable for drilling and bolting for support brackets.

Warranty: The modules should be warranted against reduction of output of no more than 10% of rated capacity over a ten-year period.

2. Specification B: Battery

2.1 Battery in System Unit of 5Wp SHS

- The battery should be installed compactly in the system unit.
- The battery type should be Lithium (Li-ion) or Nickel Metal Halide battery type. Lead Acid battery should not be used to avoid the increasing of size and weight which lead to the inconvenience of portability.
- The battery voltage and current at C10 should be 3.7V, 6600mAh (25.9 Watts, 100% efficiency use).
- The Span Life should be at least 500 Circles.

Warranty: The System Unit must be warranted against failure for a minimum of 2 years.

2.2 Battery in Lamp Unit of PSL

- The battery should be installed compactly in the lamp unit.
- The battery type should be Li-ion battery type. Lead Acid battery should not be used to avoid the increasing of size and weight which lead to the inconvenience of portability.
- The battery voltage and current at C10 should be 3.7V, 2200mAh (8.14 Watts, 100% efficiency use).
- The Span Life should be at least 500 Circles.

Warranty: The Lamp Unit must be warranted against failure for a minimum of 2 years.

3. Specification C: Lighting Source

3.1 Lighting Source of 5Wp SHS

- The light source should be 2W LED Lamp which is installed with its lamp socket.
- One output cable with 2000mm of length should be already connected to the lamp socket at one side while the other side should be connected with DC male connector. The cable's size should be big enough to prevent the power loss.
- The connector must be fit to the female connector located at the output source of the system unit.
- The lamp should be adjustable for its brightness.
- The brightness level of the lamp should be adjustable into 4modes with a switch which are switchable at 4 locations :

  a) Stage 1: 100% Brightness.
  b) Stage 2: 70% Brightness.
  c) Stage 3: 30% Brightness.
  d) Stage 4: 0% Brightness (Turn Off).

- The lamp should be super bright white LED light with 6000K to 6500K and 160-200LM.
- The lamp should be aluminum alloy case.
- The life time of the lamp should be over 50,000 Hours.

Warranty: The lamps must be warranted against failure for a minimum of 2 years.

3.3 Lighting Source of PSL

- The light source of Lamp Unit should be 1W with 16 pcs of cell of LED which is installed with the body of the lamp unit.
- The lamp should be super bright white LED light with 6000K to 6500K and 100LM.
- The brightness level of the lamp should be adjustable into 2 stages with a switch which are switchable at 2 locations:

  a) Stage 1: 100% Brightness (Turn On).
  b) Stage 2: 0% Brightness (Turn Off).

- The Lamp Unit (body) and its handle should be ABS materiel or materielequivalent.
- The globe holder of the lamp body should be transparent PC or materielequivalent.
- The life time of the lamp should be over 50,000 Hours.

4. Specification D: Input and Output

The system should be built the following input and output requirements in order to enable the users to use them with just plug and play method. The requirements were set by hearing directly from the users' demands.

4.1 Input and Output of 5Wp SHS's System Unit

4.1.1 Input

- The input connector located at the system unit should be connectable with solar module for charging.
- The input connector located at the system unit should be connectable with AC adaptor for charging.
- The input connector located at the system unit should be connectable with personal computer (USB) for charging.
- The AC adaptor should be provided to charge the battery of the system with 230V electricity.

4.1.2 Output

- USB female connector or other type of female DC connector is acceptable at output of the system unit.
- The output voltage should be 5V.
- The output current should be at lease 700mA which is enough for charging mobile product such as phone, digital camera, MP3 player…etc.
- The number of the output connectors located at the system unit with the same rate should be at least 4 outputs: 2 outputs for lamp and 2 outputs for multi-purposed usage.

4.2 Input and Output of PSL's Lamp Unit

4.2.1 Input

- The input connector located at the Lamp Unit should be connectable with solar module for charging.
- The input connector located at the Lamp Unit should be connectable with AC adaptor for charging.
- The input connector located at the Lamp Unit should be connectable with personal computer (USB) for charging.
- The AC adaptor should be provided to charge the battery of the system with 230V electricity.

4.2.2 Output

- USB female connector or other type of female DC connector is acceptable at output of the lamp unit.
- The output voltage should be 5V.
- The output current should be at lease 700mA which is enough for charging mobile product such as phone, digital camera, MP3 player…etc.

5. Specification E: Safety Protection

The system of both 5Wp SHS and PSL must have the following protection installed together to prevent the damage of the whole system and human life.

- The protection of Over Charging.
- The protection of Over Discharging.
- The protection of Short Circuit.
- The protection of decomposing by the users.

6. Specification F: Charging Time

The fully charging time is varied according the condition of charging such as the weather (sunlight, cloudy or raining...) and the placement of the solar panel. However, the charging time of the system should not be exceeded the following period at normal condition.

6.1 5Wp SHS Battery

- Charge by Solar Panel: 5-8 Hours
- Charge by Personal Computer: 8-10 Hours
- Charge by AC Transformer : 5-8 Hours

6.2 PSL Battery

- Charge by Solar Panel: 3-5 Hours
- Charge by Personal Computer: 3-5 Hours
- Charge by AC Transformer : 3-5 Hours

7. Specification G: Working Time

The working time is varied according the condition of using. However, the working time of the system should not be less than the following time period when calculating base on the number of lamp.

7.1 For 5Wp SHS

- 13Hrs 100% lighting.
- 20Hrs 70% lighting.
- 43Hrs 30% lighting.

The working hours will decrease according to the number of lamps.

7.2 For PSL

The working time is varied according the condition of using. However, the working time of the system should not be less than 8 operating hours.

8. Specification H: System Accessories

The accessories of the Pico Home Solar System included Portable Solar Lamp should be included the following items.

- 1 pcs of 5 Watts solar panel with the specification A.
- 1 unit of 5Wp SHS with specification B and D to K.
- 2 pcs of lighting source with the specification C.
- 1 set of charging accessories (adaptor for phone and mobile electronic devices).
- 1 unit of Portable Solar Lamp with specification B to K.

9. Specification I: Block Diagramof Each Unit

The System Unit of 5Wp SHS and the Lamp Unit of PHL should compose the block diagram as in Figure 1 and Figure 2 respectively.

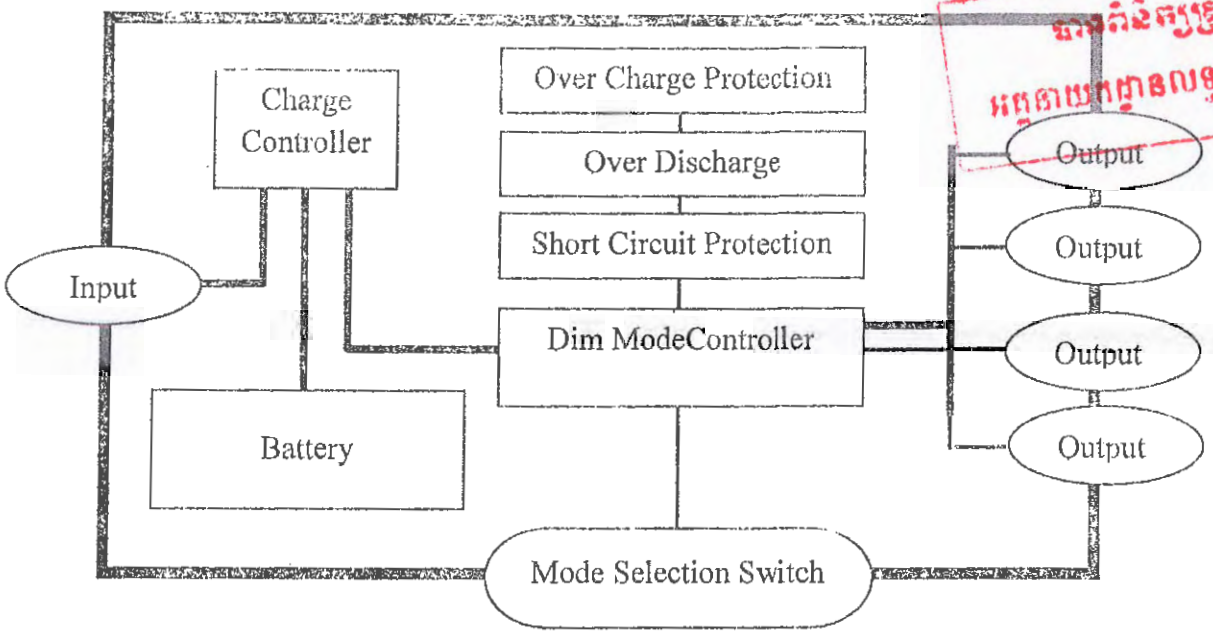

Fig 1: Block Diagram of System Unit of

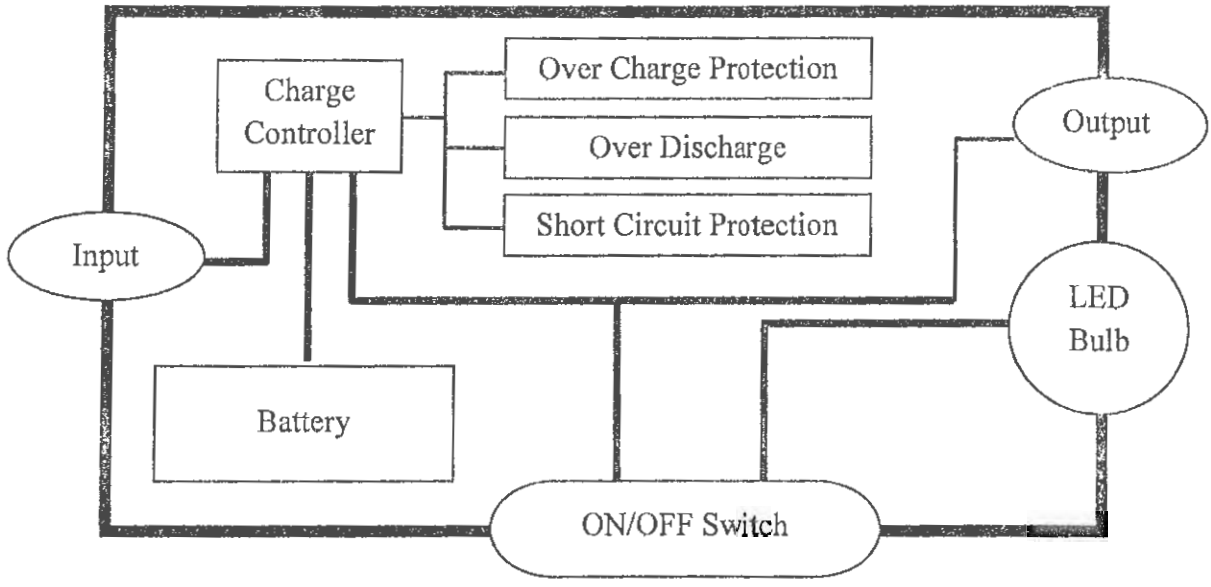

Fig 2: Block Diagram of Lamp Unit of PSL

10. Specification J: Packing Detail

The package of both 5Wp SHS and PSLshould be packaged as a gift box which all the accessories in Specification H are included.

11. Specification K : Certification of Whole System

The whole system of both 5Wp SHS and PSL should get the compliance verification to obtain the following certificate to proof the quality of the product.

- CE Certificate.
- ROHS Certificate.
- FCC Certificate.

Supply Requirements
List of Goods and Delivery Schedule
For 50Wp Solar Home Systems
(SHS)

Table 1: List of Goods and Delivery Schedule

Item N°	Description of Goods	Unit	Physical unit	Final (Project Sites) Destinations as specified in BDS	Delivery (as per Incoterms) Date		
					Earliest Delivery Date	Latest Delivery Date	Bidder's offered Delivery date [*to be provided by the bidder*]
Item 1	Nominal 50 Wp PV System	10,500	Number	Phnom Penh	30 days	60 days	
Item 2	House Kit Sub-items	1	Set		30 days	60 days	
Item 3	Spare Battery for 50 Wp systems	500	Number	Responsible by the Bidder	30 days	60 days	
Item 4	Spare 12Vdc x 7 W CFL (Compact Fluorescent Lamps)	10,000	Number		30 days	60 days	

Note: Sub-items needed per PV system for Item 1 is shown in Table 1A.
House Kit Sub-items under Item 2 are detailed in Table 1B.
Quantities per final destination for Items 1 to 2 are detailed in Table 1C.

Table 1A: Breakdown of sub-items required for each Solar PV system

Each system comprises the following sub-items	**Quantity/Size**	**Item 1**	**Specifications and standards**
Number of module per system	Number	1	
Module size range	Wp	50-55	Specification A
12Vdc battery charge controller	Number	1	Specification B
12Vdc battery charge controller	Current rate	5	Specification B
12Vdc battery rating (20h rate)	Ah per Wp	1.4 to 1.8	Specification C
Number of batteries per system	Number	1	-
Battery Boxes (self-standing per wall mounted)	Number	1	Specification F
12Vdc x 7W CFL (input power rating) with holder, reflector and insulation ring	Number	2	Specification D
Plug and socket for module inlet cable $4mm^2$	Set	1	Specification E/F
Plug and socket for load outlet cable $2.5mm^2$	Set	1	Specification E/F
Load outlet cable to lamp $1mm^2$	Set	1	Specification E/F
Circuit breaker for load outlet	Number	1 (5A)	Specification F

Table 1B: House kits sub-items

Item 2 - House kit comprises the following sub-items	Unit	Quantity	Specifications and standards
PV module inlet cable 4mm^2 stranded and flexible insulated copper, twin core sheathed and insulated (12m per system)	meter	126,000	Specification E
Load outlet cable 2.5mm^2 stranded and flexible insulated copper, twin core sheathed and insulated (3m per system)	meter	31,500	Specification E
Load outlet cable to lamp 1mm^2 stranded and flexible insulated copper, twin core sheathed and insulated (12m per system)	meter	126,000	Specification E
15A tumbler switches	Number	21,000	Specification E
Pin sockets and plugs	Number	21,000	Specification E
Supporting box for sockets and plugs	Number	10,500	Specification E
Wood screws Ø5mm x L50mm to fix the board on the wall (1)	Number	52,500	Specification E
Cable clips N4 (for 2x4mm^2)	kg	210	Specification E
Cable clips N1 (for 2x2.5mm^2)	kg	84	Specification E
Cable clips N1 (for 2x1mm^2)	kg	336	Specification E
Wire nails 10mm length	kg	210	Specification E
Bracket nails 80mm length	kg	500	Specification A
Strip connector 4mm^2	Strips of 12	1,050	Specification E
Insulation tape rolls 1cm width x 5m length	roll	1,050	Specification E
Bolts Ø6mm x L20mm (2)	Number	52,500	Specification A

Note: (1) including 4 per board + 1 spare
(2) including 4 per panel + 1 spare

Table 1C: Quantity per final destination for Items 1 to 2

Item	Description of Goods	Unit	Number of systems and sub-items per final destination [1]
Item 1	Nominal 50Wp PV System	Number	10,500
Item 2	House kits sub-items and spares:		
	PV module inlet cable 4mm^2	meter	126,000
	Load outlet cable 2.5mm^2	meter	31,500
	Load outlet cable to lamp 1mm^2	meter	126,000
	15A tumbler switches	Number	21,000
	3 Pin sockets and plugs	Number	21,000
	supporting box for sockets and plugs	Number	10,500
	Wood screws	Number[2]	52,500
	4mm^2 cable clips N4	kg	210
	2.5mm^2 cable clips N1	kg	84
	1mm^2 cable clips N1	kg	336
	Wire nails 10mm length	kg	210
	Bracket nails 80mm length	kg	500
	Strip connector 4mm^2	x12 pc	1,050
	Insulation tape rolls	rolls	1,050
	Bolts + nuts	Number[3]	52,500

Note: (1) Quantities per province may be subject to minor changes. Definite numbers to be confirmed during negotiation.
(2) Including 4 per board + 1 spare
(3) Including 4 per panel + 1 spare

Supply Requirements
List of Goods and Delivery Schedule
For 5Wp Solar Home System

Table 1: List of Goods and Delivery Schedule

Item N°	Description of Goods	Unit	Physical unit	Final (Project Sites) Destinations as specified in BDS	Delivery (as per Incoterms) Date		
					Earliest Delivery Date	Latest Delivery Date	Bidder's offered Delivery date [*to be provided by the bidder*]
Item 1	Nominal 5Wp PV System	2,000	Numbers	Phnom Penh	30 days	60 days	

Note: Sub-items needed per PV system for Item 1 is shown in Table 1A.
Quantities per final destination for Items 1 are detailed in Table 1B.

Table 1A: Breakdown of sub-items required for each Solar PV system

Each system comprises the following sub-items	Quantity/Size	Item 1	Specifications and standards
Module size range	Wp	5	Specification A
Solar Photovoltaic module and input cable 4m	Number	1	Specification A
"Plug-and-Play" system unit (Battery, Charge Controller, Protection Circuit…etc)	Number	1	Specification B and D to K (All in one)
Lighting Source (Cable 2m, LED Lamp 2W, Plug…etc)	Number	2	Specification C (All in one)
Portable Solar Lamp	Number	1	specification B to K (All in one)
Charging accessories (adaptor for phone and mobile electronic devices)	Number	1	
Kit for wall mounting of the System Unit of 5Wp SHS	Number	1	

Table 1B: Quantity per final destination for Items 1

Item	Description of Goods	Unit	Number of systems and sub-items per final destination (1)
Item 1	Solar Photovoltaic module and input cable 4m	Number	2,000
	"Plug-and-Play" system unit (Battery, Charge Controller, Protection Circuit…etc.)	Number	2,000
	Lighting Source (Cable 2m, LED Lamp 2W, Plug…etc.)	Number	4,000
	Portable Solar Lamp	Number	2,000
	Charging accessories (adaptor for phone and mobile electronic devices)	Number	2,000
	Kit for wall mounting of the System Unit of 5Wp SHS	Number	2,000

Note: (1) Quantities per province may be subject to minor changes. Definite numbers to be confirmed during negotiation.

Technical Characteristics of SHS-50Wp

Items	Description	Unit	EDC's requirement	Statement of Compliance of Bidder	Remarks
I	**Solar Photovoltaic Module(s)**				
	Country of Origin		Any country		
	Model number		Any country		
	Type (a-Si, Mono/Poly Crystalline Si,etc.)		Poly- or Mono-Crystalline		
	Min Number of cells in series per module	Number	36		
	Open circuit voltage (Voc)	V			
	Short circuit current (Isc)	A			
	Rated peak power (Pmax) at Standard Testing Condition	Wp			
	V max	V			
	I max	A			
	NOCT (Nominal Operating CellTemperature)	Deg C			
	Anodised Aluminium Frames		Yes		
	JUNCTION Box: Weatherproof,suitable Cable entry inlets / outlets, external Grounding screw, +ve and -ve terminal Mark, ULAE Certification.		Yes		

	Test certification standard		PV Cap, IEC 61215, 61646		
	Test laboratory		-		
	Attach I-V Curve		Yes		
	Test Certificate provided		Yes		
	Warrantee against reduction of output Of no more than 10%	Year	10		
	Support Structure				
	Type	(Roof/Pole)			
	Wind velocity %--Withstand Capacity	m/sec	35		
	Material				
II	**Charge Controllers (12V)**				
	Country of Origin		Any country		
	Model number		VRLA & AGM (for dry battery)		
	Enclosure material				
	Rated voltage	Vdc	12		
	Nominal Current for 50Wp	A	5		
	High voltage disconnect		Yes		
	Voltage regulation set point (Vr)	V			
	Reconnect voltage (Vrr)	V			
	Charging indicator				
	. Battery Status OK	(Yes/No)	Yes		

	. System Charging OK	(Yes/No)	Yes		
	. System Connectiong Status OK	(Yes/No)			
	Maximum Current Handling Capacity	A			
	Disconnecte Voltage	V			
	Reconnect voltage	V			
	Current draw with LEDs	mA			
	Current draw without LEDs	mA	10		
	Short circuit protection	(Yes/No)	Yes		
	Reverse polarity protection	(Yes/No)	Yes		
	Electronic over current protection	(Yes/No)	Yes		
	Lightening surge protection	(Yes/No)			
	Certifying body		PVGAP/PVRS6		
	Test certificate provided		Yes		
	Warrantee	Year	2		
	System Monitoring				
	Battery State-of-Charge indicator	(Yes/No)	Yes		
	Type of indicator				
	Indicator settings				
	Fully charged suitable to use	V			
	Energy conservation	V			
	Other (explain)				

III	**Battery**				
	Country of Origin		Any country		
	Model number				
	Battery enclosure	Open/sealed	Sealed		
	Battery type: Valve regulated Lead Acid (VRLA) and Absorbed Glass Mat (AGM) With flat or tubular plate		VRLA & AGM		
	Nominal voltage	V	12		
	Capacity per battery at C/20 down to 1.75/cell, 50Wp	Ah	50		
	Cycle life down to maximum allowable depth ofDischarge (DOD) at 25˚C				
	At (DOD) of 10%	No	1,000		
	At (DOD) of 50%	No	200		
	Self-discharge rate	(%/month)	5		
	Nominal Battery low voltage	V	12		
	Battery Gassing Voltage	V			
	Max. Charging Current (Continuous)	A			
	Max. Discharging Current (Continuous)	A			
	Certified to standard No further type test certificate if certified to PVGAP PVRS5A				
	Test certificate provided		Yes if not PV GAP Approved		

	Provide I-V Curve at specified Temperature		Yes		
	Warrantee	Year	2		
IV	**Lighting Fixtures**				
	Country of Origin		Any country		
	Model number(s)				
	Wattage(s)	W	7		
	Voltage	Vdc	12		
	Switching withstand for Ballast/lamp	Number	5,000		
	Lifetime of lamp	Hours	5,000		
	Number of fixtures per solar home unit	Number	2		
	Number of fluorescent (CFL/TFL) lights				
	Lumen output(s)	L			
	Luminous efficiency	L/W	35		
	Minimum striking voltage	V			
	Maximum continuous operating voltage	V			
	Minimum Operating frequency	kHz	20		
	Test certificate		Yes		
V	**House Kit Sub Items**				
	Wire material type		Copper		
	Insulation UV resistant of the outdoor conductors		Yes		

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	Wire sizes				
	PV module to controller	mm^2	4		
	Controller to battery and switch board	mm^2	2.5		
	Switch board to load	mm^2	1		
	Switches				
	Rated for 12Vdc or Rated for 230Vac	A dc A ac	5 15		
	Socket Outlet				
	Socket and Plugs at 12Vdc	A	5		
	12 VDC socket outlet	(Yes/No)	Yes		
	Reverse polarity protection	(Yes/No)	Yes		
	6 and/or 9V outlet	(Yes/No)			

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Technical Characteristics of SHS-5Wp

Items	Description	Unit	EDC's requirement	Statement of Compliance of Bidder	Remarks
I	**Solar Photovoltaic Module(s)**				
	Country of Origin		Any country		
	Model number				
	Type (a-Si, Mono/Poly Crystalline Si,etc.)		Poly Crystalline		
	Min Number of cells in series per module	Number	36		
	Open circuit voltage (Voc)	V	6		
	Short circuit current (Isc)	A	0.86		
	Rated peak power (Pmax) at Standard Testing Condition	Wp	5		
	V max	V	7.3		
	I max	A	0.91		
	NOCT (Nominal Operating CellTemperature)	deg C	-40°C to 50°C		
	Anodised Aluminium Frames		Yes		
	JUNCTION Box: Weatherproof,suitable Cable entry inlets / outlets, external Grounding screw, + ve and -ve terminal Mark, ULAE Ccertification.		Yes, expect external grounding screw		
	Test certification standard		CE,ROHS,FCC		

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	Test laboratory		Recognized Institute		
	Attach I-V Curve		Yes		
	Test Certificate provided		Yes		
	Warrantee against reduction of output Of no more than 10%	year	10		
	Support Structure				
	Type	(roof/Pole)	Screw		
	Wind velocity %--Withstand Capacity	m/sec	N/A		
	Material		Aluminum		
II	**Charge Controllers (V)**				
	Country of Origin		Any country		
	Model number				
	Enclosure material		Aluminum or Plastic		
	Rated voltage	Vdc	3.7		
	Nominal Current for 5Wp	A	N/A		
	High voltage Charge disconnect		4.2		
	Voltage regulation set point (Vr)	V	N/A		
	Reconnect Charge Voltage (Vrr)	V	3.7		
	Charging indicator ?	(Yes/No)	Yes		
	. Battery Status OK	(Yes/No)	Yes		
	. System Charging OK	(Yes/No)	Yes		

III	**Output Controller**				
	Brightness adjustable	Level	3		
	Level 1 (High light mode)	%	100		
	Level 2 (Mediam light mode)	%	50		
	Level 3 (Low light mode)	%	25		
IV	**Battery**				
	Country of Origin				
	Model number				
	Battery enclosure	Open/sealed	Sealed		
	Battery type: Lithium (Li-ion) or Nickel Metal Halide battery type		Lithium (Li-ion) or Nickel Metal Halide battery type		
	Nominal voltage	V	3.7V		
	Capacity per battery at C/20 down to 1.75/cell, 5Wp	Ah	6600mAh@1C		
	Cycle life down to maximum allowable depth ofDischarge (DOD) at 25°C		500		
	At (DOD) of 10%	No	N/A		
	At (DOD) of 50%	No	N/A		
	Self-discharge rate	(%/month)	1%		
	Nominal Battery low voltage	V	2.75		
	Battery Gassing Voltage	V	No gassing		
	Max. Charging Current (Continuous)	A	0.22		

	Max. Discharging Current (Continuous)	A	0.66		
	Certified to standard No further type test certificate if certified to PVGAP PVRS5A		CE,ROHS,FCC		
	Test certificate provided		Yes		
	Provide I-V Curve at specified Temperature		Not Provided		
	Warrantee	Year	2		
V	**Lamp**				
	Country of Origin		Any country		
	Model number(s)				
	Wattage(s)	W	2		
	Voltage	Vdc	3.7		
	Switching withstand for Ballast/lamp	Number	N/A		
	Lifetime of lamp	Hours	50,000		
	Number of fixtures per solar home unit	Number	2		
	Number of fluorescent (CFL/TFL) lights		NO CFL		
	Lumen output(s)	L	160-180		
	Luminous efficiency	L/W	115(nominal) up to 125		
	Minimum striking voltage	V	2.9		
	Maximum continuous operating voltage	V	3.7		
	Minimum Operating frequency	kHz	Not required		
	Test certificate		Lighting Africa		

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VI	**House Kit Sub Items**				
	Wire material type		Copper		
	Insulation UV resistant of the outdoor conductors		Yes		
	Wire sizes				
	PV module to controller	mm^2	2x1		
	Controller to battery and switch board	mm^2	2x1		
	Switch board to load	mm^2	2x1		
	Switches				
	Rated for 12Vdc	A dc A ac	3		
	Socket Outlet				
	Socket and Plugs at 12Vdc	A	3		
	12 VDC socket outlet	(Yes/No)	Yes		
	Reverse polarity protection	(Yes/No)	Yes		
	6 and/or 9V outlet	(Yes/No)	No, 5V USB		