

Technical standard for AC, DC and street light systems

Solar Street Lighting System

Concept of design:

Street lighting in off-grid areas is a necessity to ensure security in night time. Solar technology is an available and affordable technology to provide the solution. However, using solar energy for street lights is a bit tricky. One can design street lighting system in two ways: Decentralized and centralized. Decentralized system refers to an integrated system with pole mounted PV module, battery, charge controller and LED light; whereas, the centralized system refers to placement of PV module, battery and charge controllers in one place with LED lights mounted on top of poles. Each system has its own pros and cons. POs will have to decide on the appropriate design methodology based on the requirement.

12V Solar Street Light System:

1. LED light:

- Power consumption of the LED should be in the range of 10 to 50 Watt depending on the luminary requirement
- Luminous efficacy of the LED lights used should be minimum 90 Lumen/watt
- LED lights should be “White” with Color Rendering Index (CRI) of minimum 70.
- LED should provide minimum 80% of the initial lumen output after 3 years (or 5000 hours considering the lower value of usage).
- Over the input voltage range of 11.6-14.4 V (For LED with Lead Acid Batteries) and 10.0-14.2 V (For LED with Lithium Iron Phosphate Batteries), input power of the LEDs must not vary by more than 15% of the rated power.
- Temperature of the heat sink of the driver circuit of the LED luminaries should be tested and at still air condition, increase in temperature of the heat sink should not be more than 20 Degree Celsius after one hour operation.
- LEDs must be permanently engraved with model number in the body.

Warranty:

- Warranty for an LED should be 3 years.

2. Panel:

The following are applicable standards for PV modules:

- International Electrotechnical Committee (IEC) 61215: Crystalline Silicon Terrestrial PV Modules Design Qualification and Type Approval
- IEC 61646: Thin Film Silicon Terrestrial PV Modules Design Qualification and Type Approval
- IEC 60904-1: Photovoltaic Devices Part 1 Measurement of PV Current-Voltage Characteristics
- IEEE 1262: Recommended Practice for Qualification of Photovoltaic Modules
- PV GAP Recommended Standards are preferred.

- 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.
- The photovoltaic module should have a peak power output of at least 10 Wp.
- All modules must be product tested and certified.
- Each module must be factory equipped with weatherproof junction box with terminal strip that allows safe and long lasting wiring connection to the module. Where applicable, protective diodes should be used to avoid the effect of partial shading.
- Each module must be labeled indicating at a minimum: Manufacturer, Model Number, Serial Number, Peak Watt Rating, Voltage and Current at peak power, Open Circuit Voltage and Short Circuit Current of each module.
- Every year each model of PV module should be tested locally. Notable that, this will only be applicable when testing facility exists in Bangladesh and the testing authority is approved by IDCOL.
- Warranty:

A. Two (2) Year Limited PV Module Warranty

PV Modules(s) should be warranted to be free from the defects and/or failures specified below for a period not exceeding two (2) years from the date of sale to the original customer:

- 1) defects and /or failures due to manufacturing;
- 2) defects and/or failures due to materials;
- 3) cracking of the front glass surface due to foreign objects inside the glass; or
- 4) non-conformity with specifications due to faulty manufacturing and/or inspection processes.

If the PV Module(s) fails to conform to this warranty, PV module(s) should be immediately replaced.

B. Limited Power Output Warranty

Any power loss is due solely to defects in materials or workmanship; IDCOL demands the warranty of the power output of each type of PV Modules(s) as follows:

20 years (90% / 80%)

IDCOL demands that if, (a) within the first ten (10) years from the date of sale to the Customer, the PV Modules(s) exhibits a power output of less than ninety percent (90%) of the original minimum rated power specified at the time of sale, or (b) within twenty (20) years from the date of less than eighty percent (80%) of the original minimum rated power specified at the time of sale, manufacturer will repair, fix (by putting additional panel) or replace the PV Modules(s) at their own cost or refund the Purchase Price taking into account a yearly depreciation of five percent (5%) of the panel price. In case of the refund of the depreciated price of the panel, the panel will remain with the user and company will not take it from him/her. The period of power output warranty for these replaced modules(s) will be equal to the remaining warranty period of the originally supplied module(s). Notably, respective POs will be responsible to arrange all the warranty services from the respective suppliers.

3. Battery:

- Battery: Battery can be of the type of Lead Acid (GEL & AGM)/LiFePO₄/ Li-ion. Tubular plate lead acid batteries may be used in case of centralized or block based system street lighting system.
- Battery DOD should be minimum of 90%. For tubular lead acid batteries allowable DOD is 70%.
- The maximum permissible self-discharge rate is 5 percent of rated capacity per month at 25°C
- For li-ion batteries cycle life should be ≥ 1000 at 90% DoD at 25°C
- For PbA batteries cycle life of the battery (i.e., before its residual life drops below 80 percent of the rated AH capacity), at 25°C must exceed 1500 cycles when discharged down to an average depth of discharge (DOD) of 70 percent at the discharge rate of 10 hours.
- The inter-cell connection should not be exposed.
- Size of the battery in Ah should not be more than 1.5 times of panel size in Watt peak i.e. for 50Wp panel battery size should not be more than 75Ah.
- **Warranty:**
For batteries of 30 Ah and above, battery capacity will not be less than 90% of the rated for first two years and will not be less than 80% of the rated for next three years. For batteries below 30 Ah, the capacity will not be less than 90% of the rated for first year and will not be less than 80% for the next two years. In case of failure of the battery not performing as per the specification within the warranty period, the battery should be replaced.

4. Charge controller:

- Charge controller should be integrated with the system with MPPT
- Self-consumption should be less than 0.5% of the total power requirement
- The charge controller set points must be factory preset with the set points applicable to the specified battery characteristics. Charge Controllers should be dust and termite proof.
- The charge controller input current rating has to be greater than 120% of the module's rated short circuit current.
- Maximum current draw of the controller, when no LED's are lit should not exceed 20 mA and 50 mA with LED.
- The model number, serial number, rated voltages and currents, and set points should be printed on the visible side of the charge controller casing.
- Battery, high voltage disconnect 14.3 \pm 0.2 volts (for lead acid batteries), or **14.2 \pm 0.2 volts (for Lithium Iron Phosphate batteries)**. Charge controller specifications must include the type of the battery to be used with it.
- Reverse current leakage protection is recommended. Blocking diodes or logic-derived methods are both acceptable. If blocking diodes are used, they must exhibit a low forward voltage drop.
- The system must be protected against damage caused by short circuit at panel terminals and load terminals when battery is connected to the charge controller, and reverse polarity of battery or panel connections. Over-current protection must be provided. Lightning induced surge protection is recommended.
- Some means must be provided to safely disconnect the battery and the module during servicing or repair by a technician.
- The load must be controlled by a low voltage disconnect (LVD) device. The LVD must be capable of handling at least 150 percent of the maximum expected continuous load (e.g.,

assuming all end use devices are simultaneously on). It should be factory preset to disconnect and reconnect voltages corresponding to the safe operation of the battery under ambient temperature conditions. For example, for a lead acid battery, a disconnect voltage of 11.6 VDC \pm 0.1 Vdc (**10.0 \pm 0.2VDC for Lithium Iron Phosphate Batteries**) and reconnect voltage of 12.6 Vdc \pm 0.2 Vdc (**13.0 \pm 0.2VDC for Lithium Iron Phosphate Batteries**) is required.

- Each charge controller should be capable of handling at least 100 percent of the rated current at PV, battery and load terminals for at least for 1 hour without being damaged.
- Charge Controller should be capable of withstanding 25V at PV terminal when battery and load is disconnected.
- The technical specification of the charge controller must mention the input voltage range (PV panel side), input current (PV panel side), battery nominal voltage, LVD and HVD, rated output current (load side).
- The panel must have reverse polarity protection, output short circuit and over load protection.
- Efficiency of the charge controller should be at least 90%.
- **Warranty:**

Charge controller or energy meter should be replaced in case of any performance deviation from the specifications mentioned above over the period of 3 years.

Note that, a 12V solar street light package should be comprised of an LED light, a battery and a charge controller.

3.2V Solar Street Light System:

5. LED light:

- Power consumption of the LED should be in the range of 10 to 50 Watt depending on the luminary requirement
- Luminous efficacy of the LED lights used should be minimum 90 Lumen/watt
- LED lights should be “White” with Color Rendering Index (CRI) of minimum 70.
- LED should provide minimum 80% of the initial lumen output after 3 years (or 5000 hours considering the lower value of usage).
- Over the input voltage range of 2.62-3.84 V (For LED with Lithium Iron Phosphate Batteries), input power of the LEDs must not vary by more than 15% of the rated power.
- Temperature of the heat sink of the driver circuit of the LED luminaries should be tested and at still air condition, increase in temperature of the heat sink should not be more than 20 Degree Celsius after one hour operation.
- LEDs must be permanently engraved with model number in the body.

Warranty:

- Warranty for an LED should be 3 years.

6. Panel:

The following are applicable standards for PV modules:

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 - IEC 60904-1: Photovoltaic Devices Part 1 Measurement of PV Current-Voltage Characteristics
 - IEEE 1262: Recommended Practice for Qualification of Photovoltaic Modules
 - PV GAP Recommended Standards are preferred.
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- 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.
 - The photovoltaic module should have a peak power output of at least 10 Wp.
 - All modules must be product tested and certified.
 - Each module must be factory equipped with weatherproof junction box with terminal strip that allows safe and long lasting wiring connection to the module. Where applicable, protective diodes should be used to avoid the effect of partial shading.
 - Each module must be labeled indicating at a minimum: Manufacturer, Model Number, Serial Number, Peak Watt Rating, Voltage and Current at peak power, Open Circuit Voltage and Short Circuit Current of each module.
 - Every year each model of PV module should be tested locally. Notable that, this will only be applicable when testing facility exists in Bangladesh and the testing authority is approved by IDCOL.
 - Warranty:
 - A. Two (2) Year Limited PV Module Warranty**

PV Modules(s) should be warranted to be free from the defects and/or failures specified below for a period not exceeding two (2) years from the date of sale to the original customer:

- 1) defects and /or failures due to manufacturing;
- 2) defects and/or failures due to materials;
- 3) cracking of the front glass surface due to foreign objects inside the glass; or
- 4) non-conformity with specifications due to faulty manufacturing and/or inspection processes.

If the PV Module(s) fails to conform to this warranty, PV module(s) should be immediately replaced.

B. Limited Power Output Warranty

Any power loss is due solely to defects in materials or workmanship; IDCOL demands the warranty of the power output of each type of PV Modules(s) as follows:

20 years (90% / 80%)

IDCOL demands that if, (a) within the first ten (10) years from the date of sale to the Customer, the PV Modules(s) exhibits a power output of less than ninety percent (90%) of the original minimum rated power specified at the time of sale, or (b) within twenty (20) years from the date of less than eighty percent (80%) of the original minimum rated power specified at the time of sale, manufacturer will repair, fix (by putting additional panel) or replace the PV Modules(s) at their own cost or refund the Purchase Price taking into account a yearly depreciation of five percent (5%) of the panel price. In case of the refund of the depreciated price of the panel, the panel will remain with the user and company will not take it from him/her. The period of power output warranty for these replaced modules(s) will be equal to the remaining warranty period of the originally supplied module(s). Notably, respective POs will be responsible to arrange all the warranty services from the respective suppliers.

7. Battery:

- Battery: Battery can of the type of Lead Acid (GEL & AGM)/LiFePO₄/ Li-ion. Tubular plate lead acid batteries may be used in case of centralized or block based system street lighting system.
- Battery DOD should be minimum of 90%. For tubular lead acid batteries allowable DOD is 70%.
- The maximum permissible self-discharge rate is 5 percent of rated capacity per month at 25°C .
- For li-ion batteries cycle life should be ≥ 1000 at 90% DoD at 25°C
- For PbA batteries cycle life of the battery (i.e., before its residual life drops below 80 percent of the rated AH capacity), at 25°C must exceed 1500 cycles when discharged down to an average depth of discharge (DOD) of 70 percent at the discharge rate of 10 hours.
- The inter-cell connection should not be exposed.
- Size of the battery in Ah should not be more than 1.5 times of panel size in Watt peak i.e. for 50Wp panel battery size should not be more than 75Ah.
- **Warranty:**
For batteries of 30 Ah and above, battery capacity will not be less than 90% of the rated for first two years and will not be less than 80% of the rated for next three years. For batteries below 30 Ah, the capacity will not be less than 90% of the rated for first year and will not be less than 80% for the next two years. In case of failure of the battery not performing as per the specification within the warranty period, the battery should be replaced.

8. Charge controller:

- Charge controller should be integrated with the system with MPPT
- Self-consumption should be less than 0.5% of the total power requirement
- The charge controller set points must be factory preset with the set points applicable to the specified battery characteristics. Charge Controllers should be dust and termite proof.
- The charge controller input current rating has to be greater than 120% of the module's rated short circuit current.
- Maximum current draw of the controller, when no LED's are lit should not exceed 50 mA and 80 mA with LED.
- The model number, serial number, rated voltages and currents, and set points should be printed on the visible side of the charge controller casing.
- Battery, High voltage disconnect (HVD) of the charge controller should be 3.79 ± 0.05 volts. Charge controller specifications must include the type of the battery to be used with it.

- Reverse current leakage protection is recommended. Blocking diodes or logic-derived methods are both acceptable. If blocking diodes are used, they must exhibit a low forward voltage drop.
- The system must be protected against damage caused by short circuit at panel terminals and load terminals when battery is connected to the charge controller, and reverse polarity of battery or panel connections. Over-current protection must be provided. Lightning induced surge protection is recommended.
- Some means must be provided to safely disconnect the battery and the module during servicing or repair by a technician.
- The load must be controlled by a low voltage disconnect (LVD) device. The LVD must be capable of handling at least 150 percent of the maximum expected continuous load (e.g., assuming all end use devices are simultaneously on). It should be factory preset to disconnect and reconnect voltages corresponding to the safe operation of the battery under ambient temperature conditions. For example, **$2.67 \pm 0.05\text{VDC}$ for Lithium Iron Phosphate Batteries** and reconnect voltage of **$3.47 \pm 0.05\text{VDC}$ for Lithium Iron Phosphate Batteries** is required.
- Each charge controller should be capable of handling at least 100 percent of the rated current at PV, battery and load terminals for at least for 1 hour without being damaged.
- The technical specification of the charge controller must mention the input voltage range (PV panel side), input current (PV panel side), battery nominal voltage, LVD and HVD, rated output current (load side).
- The panel must have reverse polarity protection, output short circuit and over load protection.
- Efficiency of the charge controller should be at least 90%.
- **Warranty:**

Charge controller or energy meter should be replaced in case of any performance deviation from the specifications mentioned above over the period of 3 years.

Note that, a 3.2V solar street light package should be comprised of an LED light, a battery, a charge controller and a PV module.

9. Structure:

- The minimum height of the pole should be 17.5 ft above the ground and 2.5 ft under the ground.
- Pole should be made of GI or should be powder coated.
- Minimum thickness of the pole is 3.25 mm which can only be relaxed in case of centralized or block based street lighting.
- The GI pole should rest on a 2'X2' RCC base embedded at 3' depth inside the ground.
- In the ground level, 5'' cc structure may be incorporated (2'' above the ground and 3'' under the ground).

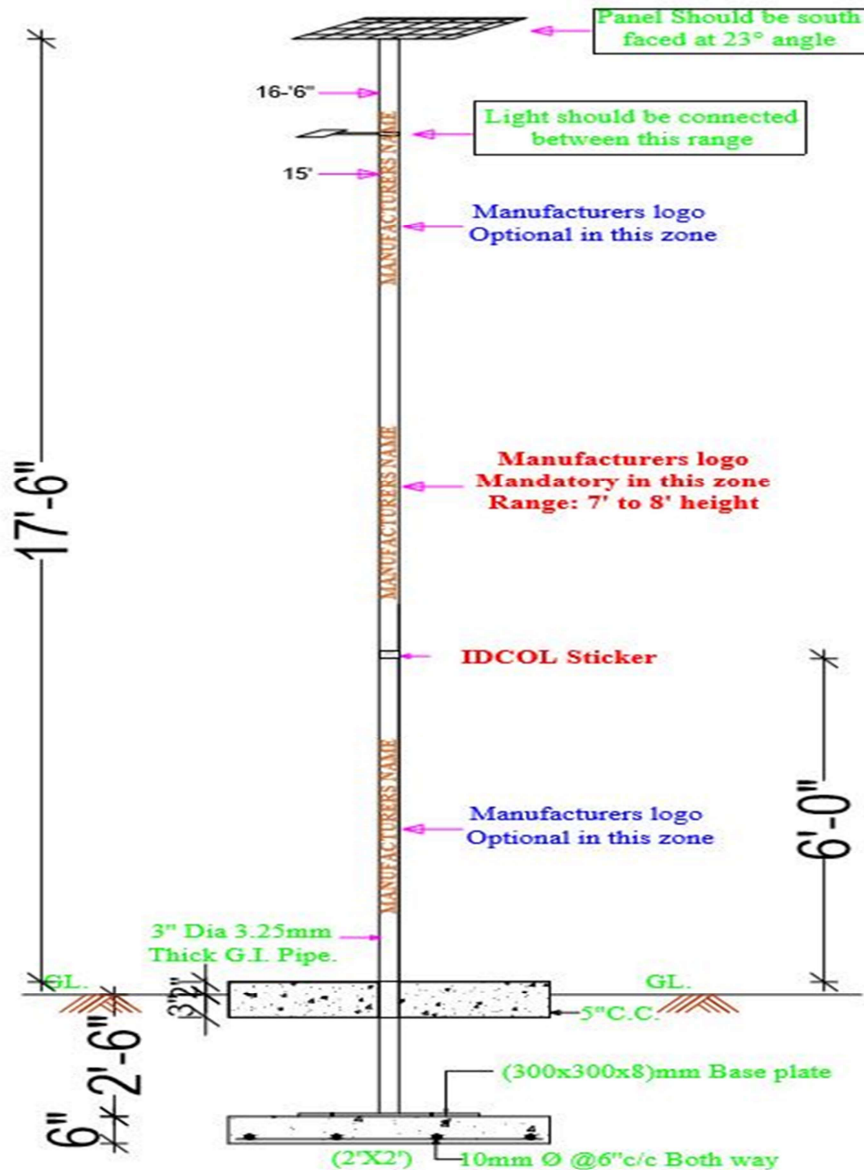


Figure 1: Street Light Design

10. System requirement:

- Charging time should be 8 hours
- Discharging time is minimum of 12 hours, might be with motion sensor or deeming option.
- Ventilation is mandatory in the system to avoid early degradation of the battery
- System should be developed to work in ambient temperature of 15⁰C-45⁰C and 100% Relative Humidity (RH).
- System must be IP 65 protected
- Total system warranty should be minimum of three years
- System should be installed in a way which can be easily dismantled and replaced, if needed.
- Centralized system voltage can be high voltage DC (up to 125V) or 230V AC.

Solar AC system

A solar AC system to be installed in the grid areas will be comprised of a solar panel, battery, charge controller, inverter and panel structure. The technical standard for solar panel, battery, charge controller will be as it is for IDCOL SHS program. The standards for inverter and panel structure are mentioned below:

11. Inverter:

- a. Efficiency at rated load should be 85% or higher.

While measuring power using resistive load in the AC side, TRUE RMS meter must be used. Voltage and current should be measured using TRUE RMS meter and resulting power should be calculated as follows:

$$\text{Power} = V_{\text{TRMS}}(\text{TRUE RMS voltage}) \times I_{\text{TRMS}}(\text{TRUE RMS current})$$

TRUE RMS meter frequency Range: $\geq 1000\text{Hz}$ (at least up to 20th harmonic).

- b. Should be able to withstand 150% of the input voltage for 1hr
- c. Operating frequency should be 47.5 to 51.5
- d. Might be of pure sine wave or modified square wave
- e. Warranty: 3 years

12. Mounting structure

- a. Should be tilted at 23° and south facing
- b. Structure should of MS
- c. Should be able to withstand 200km/hr wind speed

Solar DC system

The technical standard for the system will be as it is for IDCOL SHS program.