नेपाल सरकार
सङ्घीय मामिला तथा स्थानीय विकास मन्त्रालय
सिंहदरबार, काठमाण्डौं
नगरपालिका योजना तथा व्यवस्था शाखा (ख)

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श्री महा-नगरपालिका,
श्री उप-महानगरपालिका १२,
श्री नगरपालिका २०४, सबै ।

विषय : प्राविधिक स्पेशिफिकेशन सम्बन्धमा ।

प्रस्तुत विषयमा जनसहभागीतामा आधारित सौर्य सडक वत्ति कार्यक्रम सञ्चालन कार्यविधि २०७२ स्वीकृत भएको व्यहोरा अवगत नै छ । सौर्य सडक वत्ति कार्यक्रम सञ्चालन गर्न प्राविधिक सहयोगका लागि गठित प्राविधिक समितिले गरेको सिफारिस तथा वैकल्पिक उर्जा प्रवर्द्धन केन्द्रको प.सं. ०७२/७३, च.नं. १८७९, मिति २०७२/१२/२ को पत्रसाथ प्राप्त प्राविधिक स्पेशिफिकेशन सम्बन्धी विवरण पाना १८ संलग्न गरी पठाईएको छ । आ-आफ्नो निकायमा प्राप्त सौर्य सडक वत्ति सञ्चालन गर्ने गरी प्राप्त भएका प्रस्तावहरुको सम्भाव्यता अध्ययन फारम र लगानी विवरण सहमती (PFM) फारम यही २०७२/१२/७ गते भित्र यस मन्त्रालयमा प्राप्त हुने गरी पठाईदिनुहुन नेपाल सरकार (सचिवस्तर) को मिति २०७२/१२/४ को निर्णयानुसार अनुरोध छ ।

एकनाथ वास्तोला
शाखा अधिकृत

बोधार्थ
श्री सूचना तथा विद्युतीय शासन शाखा, Website मा विवरण राखिदिनुहुन ।

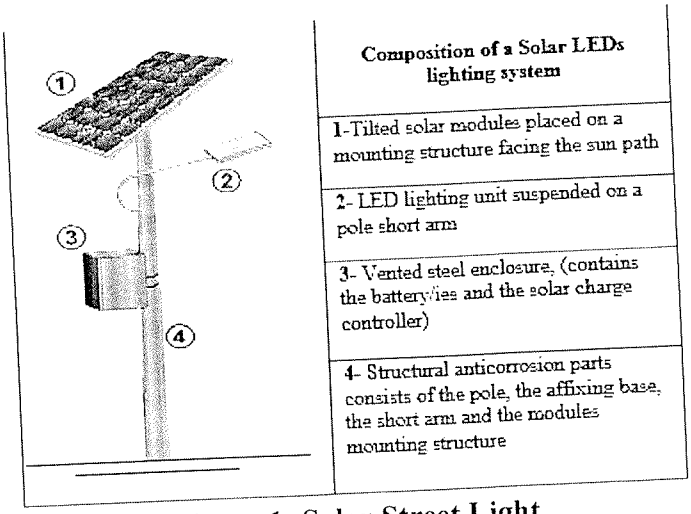
1. Background:

A standalone solar photovoltaic street lighting system is an outdoor lighting unit used for illuminating a street or an open area. Recent advances in LED lighting have brought very promising opportunities for application in street lighting. Combining LED's low power, high illumination characteristics with current photovoltaic (PV) technology, PV powered street light utilizing LED has become a norm in many places. In today's application, most of the common High Intensity Discharge (HID) lamps, often High Pressure Sodium (HPS) lamps are being replaced by more low powered Light Emitting Diode (LED) lamps.

A basic solar powered LED street light system components are:

1. Solar Panel or Photovoltaic Module
2. Lighting Fixture – LED lamp set
3. Rechargeable Deep Cycle Battery
4. Solar Charge Controller
5. Light Pole

The Solar Panel will provide electricity to charge the battery during day time. The battery's charging is controlled by a charge controller. The operation of the LED bulb is controlled by a control circuit either by using sensors such as Light Dependent Resistor (LDR) or voltage or current sensor. All these components will be fixed on a pole as shown in Figure 1 below. The solar panel is mounted at the top of the pole to minimize the possibility of any shading on the panels.



Composition of a Solar LEDs lighting system
1-Tilted solar modules placed on a mounting structure facing the sun path
2- LED lighting unit suspended on a pole short arm
3- Vented steel enclosure, (contains the batteries and the solar charge controller)
4- Structural anticorrosion parts consists of the pole, the affixing base, the short arm and the modules mounting structure

Figure 1: Solar Street Light

2. Description of basic components of solar street light system:

2.1 Solar panel

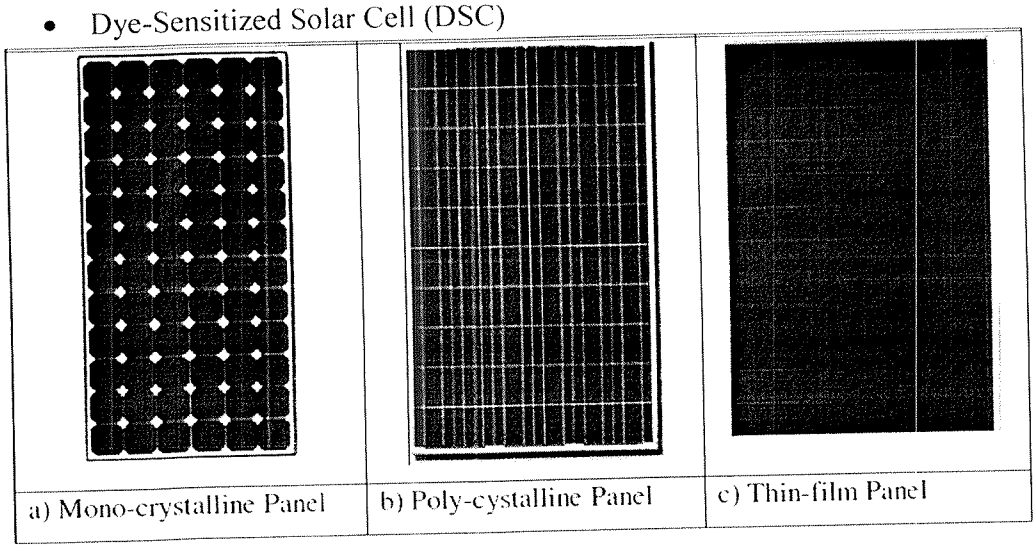
A Solar Panel is basically a module that converts light energy (photons) from the sun to generate electricity in direct current (DC) form. There are two types of solar panels, mainly crystalline and thin-film types.

There are two types of crystalline solar panels (see Figure a & b):

- Poly-crystalline Solar Panel
- Mono-crystalline Solar Panel

As for Thin-film types, there are (see Figure c):

- Amorphous Silicon (a-Si)
- Cadmium Teluride (Cd-Te)
- Copper Indium Gallium Selenide (CIGS)
- Dye-Sensitized Solar Cell (DSC)



a) Mono-crystalline Panel	b) Poly-cystalline Panel	c) Thin-film Panel

Figure 2: Types of Solar PV Module

2.2 Battery

Batteries are used to store the electricity generated by the solar panel. During the day, electricity generated by the solar panels is supplied to the battery and/or the load. When the load demand is higher than the energy received from the solar panels, these batteries will provide stable energy to the load. Solar power applications typically use deep-cycle batteries because they can persist repeated and deep discharges. There are a few types of rechargeable batteries, which are:

(i) Lead-Acid (LA) Battery

These batteries are the most commonly used in solar powered systems due to its maturity in technology and low pricing. They can only be used with low Depth of Discharge (DOD) in order to extend its lifespan. Its DOD ranges from 60%-80%. There are two types of Lead-Acid batteries, i.e. flooded and Valve Regulated Lead Acid (VRLA) batteries which are maintenance free batteries.

(ii) Nickel-Cadmium (Ni-Cad) Battery

Nickel-Cadmium (Ni-Cad) batteries are expensive and disposing of Cadmium is hazardous. Even though they have several advantages over Lead-Acid batteries, such as longer life span, and tolerance for higher discharge, Ni-Cd batteries is not commonly used in solar powered systems due to its high cost and limited availability.

(iii) Lithium-Ion (LI) or Lithium-Polymer (LP) Battery

Lithium based batteries are considered the future of batteries used in solar powered systems. This is due to a number of factors such as high specific energy, high DOD, and higher number of charging cycles. However, due to its higher cost compared to LA type of batteries, they are still not very widely used.

2.3 LED lamp

A LED lamp is a light-emitting diode (LED) product that is assembled into a lamp (or light bulb) for use in lighting fixtures. LED lamps have a lifespan and electrical efficiency that is several times better than incandescent lamps, and significantly better than most fluorescent lamps, with LED able to emit more than 100 lumens per watt.LED are the perfect combinations with solar power as it operates under low voltage, low heat and low power requirement.

Like incandescent lamps and unlike most fluorescent lamps (e.g. tubes and CFL), LED lights come to full brightness without need for a warm-up time; the life of fluorescent lighting is also reduced by frequent switching on and off. Initial cost of LED is usually higher. LED chips need controlled direct current (DC) electrical power; an appropriate power supply is needed. LEDs are adversely affected by high temperature, so LED lamps typically include heat dissipation elements such as heat sinks and cooling fins.

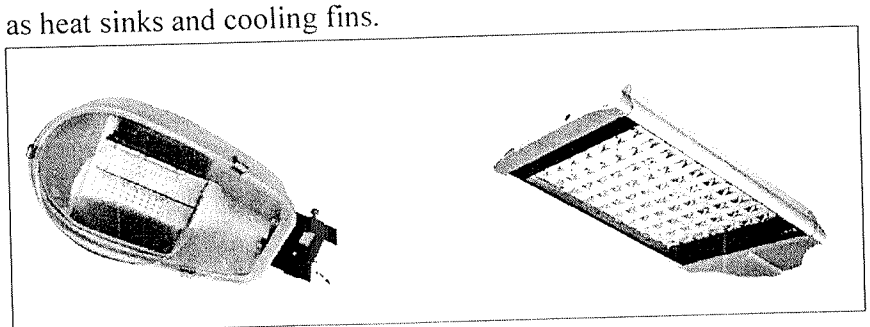


Figure 3: Examples of LED solar street lamps

2.4 Charge controller

Charge controllers are used to control the charging of the batteries. Since the output from solar panels are variable and needs adjustments, charge controllers fetches the variable voltage/current from solar panels, condition it to suit the safety of the batteries. The main functions of charge controllers are to prevent over-charging of batteries from solar panels, over-discharging of batteries to the load and to control the functionalities of the load.

Charge controllers are basically DC-DC converters, where PWM or MPPT technique is used to regulate the switches of the controller. There are three general types of charge controller, mainly:

- Simple ON/OFF Controller
- Pulse Width Modulated (PWM) Controller
- Maximum Power Point Tracking (MPPT) Controller

Most charge controllers operate at three stages to complete the charging cycle of the batteries. These stages vary according to different times and battery voltages. PWM can be employed to control the charging at the stages:

- BULK stage
- ABSORPTION stage
- FLOAT stage

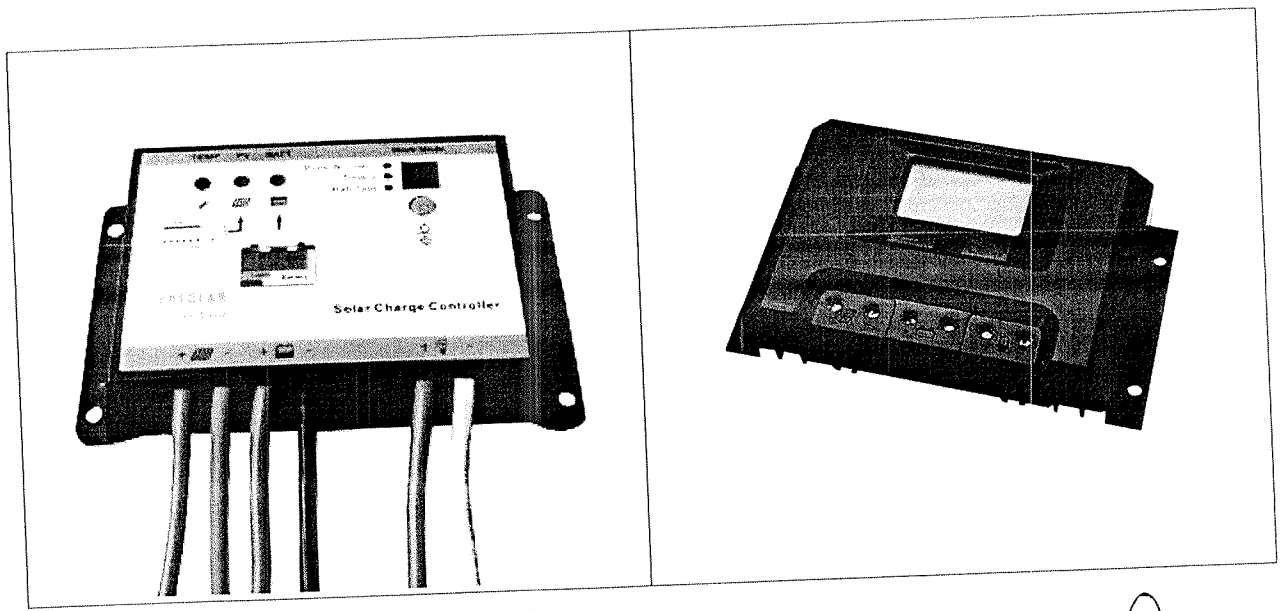


Figure 4: Examples of charge controller

2.5 Utilizing sensors to obtain energy-efficient solar powered street lights

For economical and technical viability, optimized solar powered street lights are obtained using sensors. Sensors such as Ultrasonic sensors, IR Sensors and LDR sensors are used to control the LED lamp functionalities in order to achieve a more energy efficient system. In this case the street light must have auto on and off and must have at least two state of dimming function to save energy, from dusk to dawn.

3. Installation of solar street light system:

The configuration of solar street light system must be designed to be robust and must be good enough to withstand the harsh environmental condition as the system are installed in road where it is continuously exposed to sun, rain, fog, pollution etc. The solar street lighting installation shall not damage aesthetic of the existing city or street plan; rather it shall add beauty to the existing roadway. The solar street lights can be installed in following two ways:

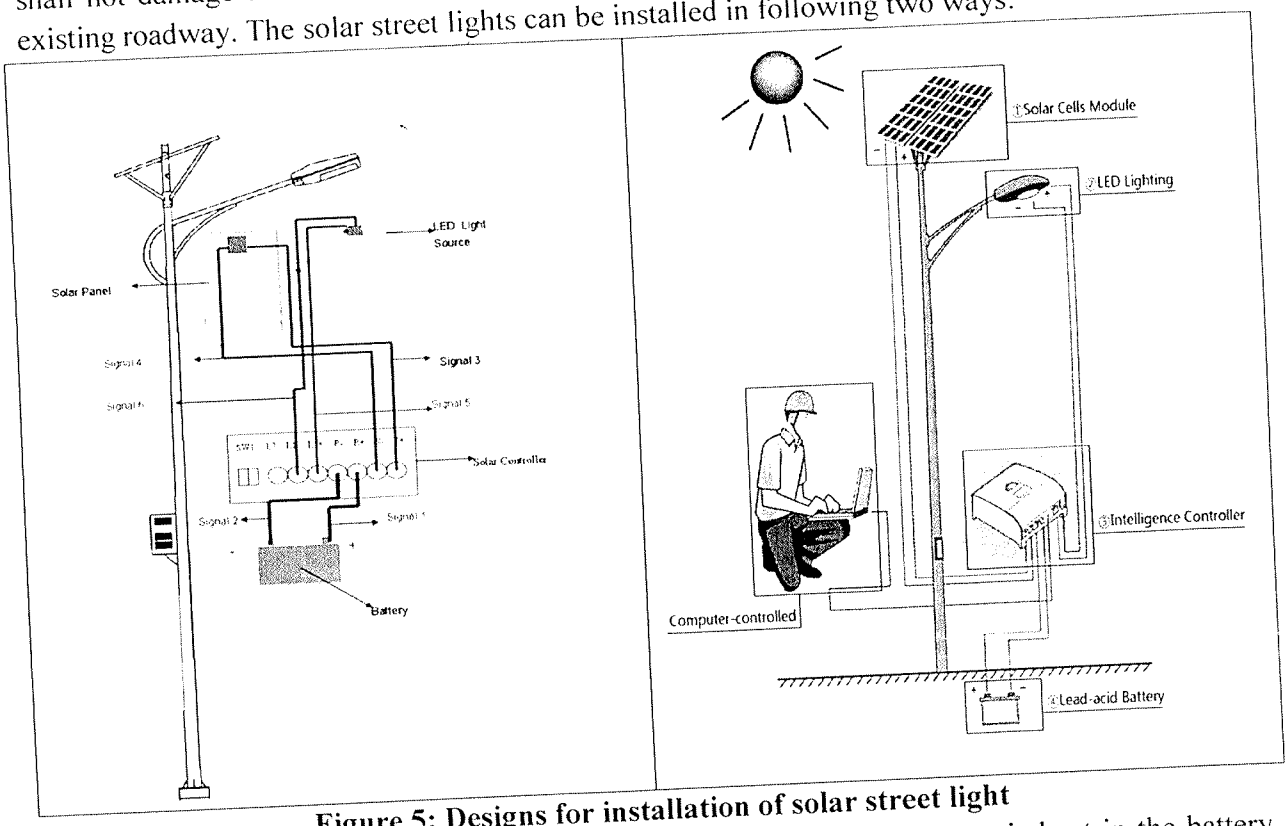


Figure 5: Designs for installation of solar street light

In above figure, first configuration depicts the situation where the battery is kept in the battery box on the pole whereas in second configuration the battery is installed in underground. Either of the configurations can be considered for installation of the system, and it has to be decided case wise case depending upon the requirement of the project site. Nevertheless the battery box mounted on the light pole is common practice in case of stand-alone solar street lighting systems.

2. Defining of packages:

The packages have been defined based on the power consumption of lamps. The package will be selected based on the nature and size of the road for which the solar street light system is being designed.

SSLS Type	Lamp Size (Watt)	Minimum Solar PV Module Size (Wp)	Minimum Battery Size for Lead Acid(AH)	Minimum Battery Size for Lithium Ion (AH)	Minimum Charge Controller Size (A)	Height of pole in meter	Recommended for road having Right of Way (ROW)
Type 1	10	50	40	30	5	7	Less than 4 M
Type 2	20	100	60	45	10	7	4-6 M
Type 3	30	150	80	60	12	7	>6-10 M
Type 4	40	200	100	75	15	8 or 9	>10 -14 M
Type 5	60	300	150	115	25	8 or 9	>14 -20 M
Type 6	80	400	200	150	30	10	>20 – 30 M
Type 7	100	500	250	180	40	10	>30 M

Table 1: Types of Solar Street Light System

3. Technical Specification:

Scope of works shall include:

a. All necessary Spare parts/Tools have to be provided by the contractor.
b. Suitable Carrying case (if possible) should be provided by the contractor.
c. The complete Set of Goods shall be warranted by the contractor against any manufacturing/ design/ installation defects for a minimum period of **5 years** from the date of installation.
d. The contractor will make all necessary arrangements for satisfactory operation, maintenance and performance of the Goods during 5 year's Warrantee/Guarantee period.
e. Rectification of all the defects developed in the Goods during Warrantee/Guarantee period shall have to be done by the contractor promptly, at the most within 7 days from the date of receipt of compliant.
f. Warrantee/Guarantee will include rectification /replacement of all the defective and consumable components/items. During Warrantee/Guarantee period, all the arrangements for keeping all the goods functional shall be the sole responsibility of the contractor.
g. After completion of the proposed works, clearances of all temporary works/ materials shall be the sole responsibility of the contractor and this shall be removed immediate after the requirement of such temporary work is completed.
h. All the non functional parts/ materials/ items replaced during the Warrantee/Guarantee period shall be the property of the contractor.
i. The contractor will conduct on-site training of the purchaser's/user's personnel regarding the assembly, start-up, operation, maintenance and repairs of the Goods.
j. Contractor should have enough experience and qualified technical staff to do design, installation and support. Name, experience certificates and CVs of the engineering staff who will supervise the installation and support should be included.
k. The contractor must nominate in the offer a qualified project manager who should have at least a B.Sc. in electrical/Mechanical/Civil engineering with a minimum experience of 2 years in PV system projects.
l. All works carried-out by the contractor should be maintained and ensure proper functioning of street light for five years starting from the date of final acceptance.
m. The Contractor will be responsible for all engineering and design.
n. The contractor will be responsible for cleaning of the solar PV module for at least five years from the date of installation and commissioning.

Technical Specifications:

The bidder must furnish documentary evidence in the form of literature (catalogue), certified dimensional drawings, and detailed description of goods with essential technical information. All data, drawings, catalogues and other technical documents shall be bound separately from the Bid documents.

The Bidder shall furnish a clause-by-clause commentary on specification, specifying compliance and deviations, if any. This must be furnished; otherwise, the Bid may be rejected.

1. BATTERY

SN	Description	Specification
1.1	Manufacturer Name	
1.2	Brand/Model	
1.3	Battery Type	Lead Acid Sealed- Gel Tubular VRLA solar deep cycle or Lithium ion with proper protection
1.4	Battery Voltage	For Lead Acid battery: 12V For Lithium Ion battery the bidder must propose the voltage compatible to system
1.5	Battery Efficiency	Minimum 85%
1.6	Quantity (mention capacity)	Individual battery must be of at least ..... *(Capacity must be selected as per the type of solar street light mentioned in table 1)*
1.7	Pressure Regulation	The battery shall be provided with pressure regulation valve, which shall be self-re-sealable and flame retardant
1.8	Self Discharge	less than 3% per month
1.9	Operating Temperature	-5 °C to 55°C
1.10	Instruction	Charging instructions shall be provided along with the batteries
1.11	Warranty	5 years replacement guarantee.

1.12	Construction	**For Lead Acid Battery:** **Positive Plate:** Tubular Plate with lead or alloy spine grid. **Separator:** Micro porous synthetic separator **Electrolyte:** Sulphuric acid. **VRLA Terminals:** Epoxy sealed terminals with threaded lead-plated copper alloy
1.13	Battery Life Cycle	At least 1500 at 80% DoD
1.14	Certification	RETS Certified

The following minimum information must be included on the label of the battery and label of battery must be fixed firmly or screen printed on the battery casing:

- Brand and name of Manufacturer
- Model and type
- Rated capacity in Ampere-hours
- Nominal Voltage

2. Solar PV MODULES

Solar PV Modules will be procured from companies, complying with the standard set forth in Nepal by AEPC. PV modules shall typically be tested for durability and reliability according to standards developed by the International Electro-technical Commission. Standards IEC61215 (for crystalline silicon modules) include, amongst others, tests for thermal cycling, humidity and freezing, mechanical stress and twist, hail resistance and performance under fixed test conditions.

SN	Description	Specification
2.1	Manufacturer Name	
2.2	Brand/Model	
2.3	Module Capacity	Minimum Module Capacity must be.....*(Capacity must be selected as per the type of solar street light mentioned in table 1)*
2.4	PV module Type	Mono or Poly Crystalline or Thin Film