Ministry of New and Renewable Energy
Jawaharlal Nehru National solar Mission

TECHNICAL SPECIFICATIONS FOR COMPACT FLUORESCENT LAMP (CFL) BASED SOLAR PHOTOVOLTAIC LIGHTING SYSTEMS
(Off-grid Solar Applications Scheme 2012-2013)

COMPACT FLUORESCENT LAMP (CFL) BASED SOLAR LANTERN

A Solar Lantern is a portable lighting device consisting of a PV module, battery, lamp, and electronics. Battery, lamp, and electronics are placed in a suitable housing, made of metal or plastic or fiber glass. The Solar lantern is suitable for either indoor or outdoor lighting, covering a full range of 360 degrees.

PV module converts sun light into electricity, charges the battery which powers the luminaire. Luminaire consists of Compact Fluorescent Lamp (CFL) and an Electronic Circuit.

BROAD PERFORMANCE SPECIFICATIONS

The broad performance specifications of a CFL light source based solar lantern system are given below:

PV Module	10 Wp under STC
Battery	Sealed Maintenance Free (SMF) lead acid battery or NiMH battery or Lithium Ion Battery
Light Source	7 Watt CFL luminaire with 4 pins only along with proper pre-heating circuit
Electronics	Efficiency approximately 85%
Duty cycle	4 hours a day under average daily insolation of 5.5 kWh/ sq.m. on a horizontal surface.
Autonomy	Minimum of 3 days or 12 operating hours per permissible discharge

TECHNICAL DETAILS

PV MODULE

(i) Indigenously manufactured PV modules should be used in the solar lantern.

(ii) The PV module should have crystalline silicon solar cells, and should have a test certificate conforming to IEC 61215 Edition II / BIS 14286 from an NABL or IECQ accredited Laboratory. In case the certificate for the offered module is not available, a test certificate for higher capacity module produced by the same PV module manufacturer should be available.

(iii) The PV module must have a minimum of 10 Wp at a load voltage* of 16.40 ±0.2 V under the standard test conditions (STC) of measurement.

(iv) The open circuit voltage* of the PV modules under STC should be at least 21.0 Volts.

(v) **The module efficiency should not be less than 10%.**

(vi) The terminal box on the module should have a provision of opening it for replacing the cable, if required.

(vii) There should preferably be an arrangement (stand) for mounting the module at an optimum angle in the direction facing the sun.

(viii) A foil/ strip containing the following details should be fixed inside the module so as to be clearly visible from the front side:-
a) Name of the Manufacturer and/ or distinctive Logo
b) Model and/ or Type No.
c) Serial No.
d) Year of manufacture

(vii) **A distinctive serial number starting with NSM will be engraved on the frame of the module or screen printed on the tedlar sheet of the module.**

*****The load and open circuit voltage conditions of the PV module are not applicable for the system having MPPT.

BATTERY

(i) Sealed maintenance free lead acid battery with a capacity of up to 7 AH, at voltages of up to 12V @ C/20 rate of discharge rate at 27^{o}C.
or NiMH or Lithium Ion battery of requisite capacity

(ii) For lead acid battery, 80% of the rated battery capacity (~ 5.6 AH at 27^{o}C) should be between the low voltage cut off and full charge condition of the battery.

(iii) Battery should conform to the latest BIS/ International standards.

LIGHT SOURCE

i. The lamp should be a 7 Watt compact fluorescent lamp (CFL) with 4 pins only along with proper pre-heating circuit.

ii. The lamp should preferably be mounted in a base up configuration. For the lantern to be used in the cold areas like Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Uttarakhand, etc. it could have the lamp base down configuration.

iii. The light output should be 370±5% lumen for a 7W CFL lamp.

iv. The housing should be suitable for indoor as well as outdoor use.

ELECTRONICS

(i) The inverter should be of quasi-sine wave/sine wave type with a crest factor less than 1.7 and the frequency in the range of 20-35 kHz.

(ii) Efficiency of the electronic system should be at least 85%.
(iii) Electronics should have temperature compensation for proper charging of the battery throughout the year.
(iv) The idle current should not be more than 1 mA.
(v) The voltage drop from module terminals to the battery terminals should not exceed 0.6 volts including the drop across the diode and the cable when measured at maximum charging current.
(vi) The PCB containing the electronics should be capable of solder free installation and placement.
(vii) The electronics circuit should ensure full charging of the battery under different ambient temperatures (0 - 45^{o}C). Further, the electronic circuit should have adequate temperature compensation arrangement for the battery charge regulation set point/ high voltage disconnect for proper charging of the battery throughout the year.
(viii) Necessary lengths of wires/ cables, switches suitable for DC use and other protections should be provided.

ELECTRONIC PROTECTIONS

(i) Adequate protection is to be incorporated for “No Load” condition, e.g. when the lamp is removed and the lantern is switched ON.
(ii) The system should have protection against battery overcharge and deep discharge conditions.
(iii) The load reconnect should be provided at around 80% of the battery capacity status.
(iv) Adequate protection should be provided against battery reverse polarity.
(v) A fuse should be provided to protect against short circuit conditions.
(vi) Protection for reverse flow of current through the PV module should be provided.
(vii) During the charging, lamp cannot be Switched “ON”.

INDICATORS

The system should have two indicators, green and red.
The green indicator should indicate the charging under progress and should glow only when the charging is taking place. It should stop glowing when the battery is fully charged.
Red indicator should indicate the battery “Load Cut Off” condition.

QUALITY AND WARRANTY

(i) The complete Solar Lantern with CFL should be warranted for five years and the battery must be warranted for a minimum period of Two (2) years.
(ii) The Warrantee/ Guarantee Card to be supplied with the Solar Lantern must contain the details of the system supplied.

OPERATION and MAINTENANCE MANUAL

An Operation, Instruction and Maintenance Manual, in English and the local language, should be provided with the Solar Lantern. The following minimum details must be provided in the Manual:

- Basic principles of Photovoltaics.
- A small write-up (with a block diagram) on Solar Lanterns - its components, PV module, battery, electronics and luminaire and expected performance.
- Significance of indicators.
- Type, Model number, Voltage, capacity of the battery, used in the system.
- The make and wattage of the CFL used in the lighting system.
- Clear instructions on mounting, operation, regular maintenance and trouble shooting of the Solar Lantern.
- Instructions on replacement of battery.
- DO's and DONT's.
- Name and address of the contact person for repair and maintenance during the warranty.

COMPACT FLUORESCENT LAMP (CFL) BASED SOLAR HOME LIGHTING SYSTEMS

A solar home lighting system (SHS) provides a comfortable level of illumination in one or more rooms of a house. The SHS consists of a PV module, control electronics, battery, and luminaire(s). There are several SHS models featuring one, two, or four luminaires based on Compact Fluorescent Lamp (CFL). The system could also be used to run a small DC fan or a 12-V DC television along with the CFL.

PV module converts sunlight into electricity, which powers the luminaire(s), which consists of Compact Fluorescent Lamp (CFL) and an Electronic Circuit.

BROAD PERFORMANCE SPECIFICATIONS

The broad performance specifications of a CFL light source based solar home lighting system are given below:

PV Module	18-74 Watt peak under STC
Battery	Lead acid sealed maintenance free, Lead acid tubular flooded or Gel / VRLA or NiMH or Lithium-Ion
Light Source	9-11 Watt CFL
Light output	600±5 % lumens for 9 W CFL and 900±5 % lumens for 11 W CFL.
Mounting of light	Wall or ceiling
Electronics	Min 85 % efficiency
Inverter	Quasi sine wave or sine wave type
Average duty cycle	5 hours a day under average daily insolation of 5.5 kWh/ sq.m. on a horizontal surface.
Autonomy	3 days or Minimum 15 operating hours per permissible discharge

There are four models of CFL home lighting systems. The configuration of each model is as follows:

Model-1 One Light

PV Module	18 Wp under STC
Lamp	One CFL of 9W or 11W
Battery	One 12V-20 AH @ C/20 Lead acid Sealed maintenance free, Tubular positive plate flooded electrolyte or Gel or VRLA Type or NiMH or Lithium-Ion of requisite capacity
Other components	Control electronics, module mounting hardware, battery box, inter-connecting wires/ cables, switches, etc.

Model-2 2 Lights

PV Module	1x 37 Wp under STC
Lamps	2x CFLs of 9W or 11W each
Battery	1x12V, 40 AH Lead Acid, Tubular positive plate flooded electrolyte or Gel or VRLA Type. or NiMH or Lithium-Ion of requisite capacity
Other components	Control electronics, module mounting hardware, battery box, inter-connecting wires/ cables, switches, etc.

Model-3 2 lights and 1 fan

PV Module(s)	2x 37 W or 1x 74 W under STC
Lamps	2x CFLs of 9W or 11W each
Fan	1x DC Fan with wattage less than 20 W
Battery	1x12V, 75 AH Lead Acid, Tubular positive plate flooded electrolyte or Gel or VRLA Type.
Other components	Control electronics, module mounting hardware, battery box, inter-connecting wires/ cables, switches, etc.

Model-4 4 lights

PV Module(s)	2x 37 W or 1 x74 W under STC
Lamps	4xCFLs of 9W or 11W each
Battery	1x12V, 75 AH Lead Acid, Tubular positive plate flooded electrolyte or Gel or VRLA Type.
Other components	Control electronics, module mounting hardware, battery box, inter-connecting wires/ cables, switches, etc.

Notes:

i) All models should have a socket to provide power for a 12V DC TV set which can be purchased separately.
ii) A small white LED could be provided as an optional feature, with an independent switch.

TECHNICAL DETAILS

PV MODULE (S)

i. Indigenously manufactured PV modules should be used
ii. The PV module should be made up of crystalline silicon solar cells and must have a certificate of testing conforming to IEC 61215 Edition II / BIS 14286 from an NABL or IECQ accredited Laboratory. In case the certificate for the offered module is not available, a test certificate for higher capacity module produced by

the same PV module manufacturer should be available.

iii. The power output of the module(s) under STC should be a minimum of 18 Wp or 37 Wp or 74 Wp. In **Model-4** either two modules of 37 Wp each or one module of 74 Wp can be used.

iv. The Load voltage* corresponding to the power output mentioned above should be 16.4±0.2V.

v. The Open Circuit Voltage* of the PV modules under STC should be at least 21.0 Volts.

vi. **The module efficiency should not be less than 10% for 18 Wp, 12% for 37 Wp and 14% for 74 Wp modules.**

vii. The terminal box on the module should have a provision for opening, for replacing the cable, if required.

viii. There should be a Name Plate fixed inside the module which will give:
   a. Name of the Manufacturer or Distinctive Logo.
   b. Model Number
   c. Serial Number
   d. Year of manufacture

ix. Each PV module having capacity equal to 37 Wp or more must use a RF identification tag (RFID), which must contain the following information:
   (i) Name of the manufacturer of PV Module
   (ii) Model or Type Number
   (iii) Serial Number
   (iv) Month and year of the manufacture
   (v) I-V curve for the module
   (vi) Peak Wattage of the module at 16.4 volts
   (vii) Im, Vm and FF for the module
   (viii) Unique Serial No and Model No of the module

   Until March 2013, the RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions. **However from 1st April 2013 onwards; RFID shall be mandatorily placed inside the module laminate**.

x. A distinctive serial number starting with NSM will be engraved on the frame of the module or screen printed on the tedlar sheet of the module.

*****The Load voltage and Open Circuit Voltage conditions of the PV modules are not applicable for the system having MPPT.

BATTERY

(i) For **Model-1**, sealed maintenance free lead acid battery with a capacity of up to 20 AH, at voltages of 12V @ C/10 rate of discharge or NiMH or Lithium Ion battery of requisite capacity.

(ii) For **Models–2, 3, 4**, battery should be Lead Acid, Tubular positive plate flooded electrolyte or Gel or VRLA Type and have a minimum rating of 12V,

40 Ah or 12V, 75 Ah at C/10 rate of discharge, depending on the Model.

(iii) 75 % of the rated capacity of the battery should be between fully charged & load cut off conditions.

(iv) Battery should conform to the latest BIS/ International standards.

LIGHT SOURCE

(i) The lamp should be a 9 Watt or 11 Watt compact fluorescent lamp (CFL) with 4 pins only along with proper pre-heating circuit

(ii) The light output from the lamps should be around 600±5 % lumens for 9 W CFL and 900±5 % lumens for 11 W CFL.

(iii) The lamps should be housed in an assembly suitable for indoor use, with a reflector on its back.

(iv) While fixing the assembly, the lamp should be preferably held in a base up configuration. In the cold areas of Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir and Uttarakhand solar home lighting systems could have the lamp base down configuration.

(v) No blackening or reduction in the lumen output by more than 10% should be observed after 1000 ON/OFF cycles - two minutes ON followed by four minutes OFF is one cycle.

ELECTRONICS

i. The total electronic efficiency should be at least 85 %.

ii. The inverter should be of quasi sine wave/sine wave type, with frequency in the range of 20 - 30 kHz. Half-wave operation is not acceptable.

iii. Electronics should have temperature compensation for proper charging of the battery throughout the year. The idle current should be less than 2 mA for **Models-I & II**, and for **Models-III & IV**, it should be less than 5mA.

iv. The voltage drop from module terminals to the battery terminals should not exceed 0.6 volts including the drop across the diode and the cable when measured at maximum charging current.

v. The PCB containing the electronics should be capable of solder free installation and replacement.

vi. Necessary lengths of wires/cables, switches suitable for DC use and fuses should be provided.

DC FAN

The wattage of the fan should not be more than 20 Watts and it should operate at 12V DC.

ELECTRONIC PROTECTIONS

(i) Adequate protection should be incorporated under “No Load” condition, e.g. when the lamps are removed and the system is switched ON.

(ii) The system should have protection against battery overcharge, deep discharge condition.
(iii) Load reconnect should be provided at 80% of the battery capacity status.
(iv) Adequate protection should be provided against battery reverse polarity.
(v) Fuses should be provided to protect against short circuit conditions.
(vi) Protection for reverse flow of current through the PV module(s) should be provided.
(vii) Electronics should have proper temperature compensation for proper charging of the battery throughout the year.

MECHANICAL COMPONENTS

(i) Corrosion resistant metallic frame structure should be provided to hold the SPV module.
(ii) The frame structure should have provision to adjust its angle of inclination to the horizontal, so that it can be installed at the specified tilt angle.
(iii) Light source should be either for wall mounted or ceiling mounted or can be hung from the ceiling in a stable manner, as per site requirements.
(iv) A vented plastic/ wooden/ metallic box with acid proof corrosion resistant paint for housing the storage battery indoors should be provided.

INDICATORS

The system should have two indicators, green and red.
The green indicator should indicate the charging under progress and should glow only when the charging is taking place. It should stop glowing when the battery is fully charged.
Red indicator should indicate the battery “Load Cut Off” condition

QUALITY AND WARRANTY

(i) All the components and parts used in solar home systems should conform to the latest BIS or IEC specifications, wherever such specifications are available and applicable.
(ii) **The Solar home lighting system including the battery will be warranted for a period of five years from the date of supply**.
(iii) **The PV module(s) will be warranted for a minimum period of 25 years from the date of supply.** PV modules used in Solar Home Lighting System must be warranted for their output peak watt capacity, which should not be less than 90% at the end of Ten (10) years and 80% at the end of Twenty five (25) years.
(iv) The Warranty Card to be supplied with the system must contain the details of the system**.** The manufacturers can also provide additional information about the system and conditions of warranty as necessary.

OPERATION and MAINTENANCE MANUAL

An Operation, Instruction and Maintenance Manual, in English and the local language, should be provided with the Solar Home Lighting System. The following minimum details must be provided in the Manual:

- Basic principles of Photovoltaics.
- A small write-up (with a block diagram) on Solar Home Lighting System - its components, PV module, battery, electronics and luminaire and expected performance.
- Significance of indicators.
- Type, Model number, voltage & capacity of the battery, used in the system.
- The make and wattage of the CFL used in the lighting system.
- The make and wattage of the CFL used in the lighting system.
- Clear instructions about mounting of PV module(s).
- Clear instructions on regular maintenance and trouble shooting of the Solar Home Lighting System.
- DO's and DONT's.
- Name and address of the contact person for repair and maintenance.

COMPACT FLUORESCENT LAMP (CFL) BASED SOLAR STREET LIGHTING SYSTEM

A stand alone solar photovoltaic street lighting system (SLS) is an outdoor lighting unit used for illuminating a street or an open area. The Solar Street Lighting System consists of solar photovoltaic (SPV) module, a luminaire, storage battery, control electronics, inter-connecting wires/cables, module mounting pole including hardware and battery box. The luminaire is based on Compact Fluorescent Lamp (CFL) which emits light when electric current passes through it. The luminaire is mounted on the pole at a suitable angle to maximize illumination on the ground. The PV module is placed at the top of the pole at an angle facing south so that it receives solar radiation throughout the day, without any shadow falling on it. A battery is placed in a box attached to the pole.

Electricity generated by the PV module charges the battery during the day time which powers the luminaire from dusk to dawn. The system lights at dusk and switches off at dawn automatically.

BROAD PERFORMANCE SPECIFICATIONS

PV Module	74 Wp under STC
Battery	Lead acid Tubular Flooded or Tubular GEL / VRLA , 12V- 75 AH @ C/10
Light Source	Compact Fluorescent Lamp of 11 Watt
Light Out put	900±5 % lumens.
Mounting of light	Minimum 4 metre pole mounted
Electronics Efficiency	Minimum 85% total
Inverter	Quasi sine wave or sine wave type
Duty Cycle	Dusk to dawn
Autonomy	3 days or Minimum 42 operating hours per permissible discharge

TECHNICAL DETAILS

PV MODULE

(i) Indigenously manufactured PV module should be used.

(ii) The PV module should have crystalline silicon solar cells and must have a certificate of testing conforming to IEC 61215 Edition II / BIS 14286 from an NABL or IECQ accredited Laboratory. In case the certificate for the offered module is not available, a test certificate for higher capacity module produced by the same PV module manufacturer should be available.

(iii) The power output of the module(s) under STC should be a minimum of 74 Wp at a load voltage* of 16.4 ± 0.2 V. Either two modules of minimum 37 Wp output each or one module of 74 Wp output should be used.

(iv) The open circuit voltage* of the PV modules under STC should be at least 21.0 Volts.

(v) **The module efficiency should not be less than 14 %.**

(vi) The terminal box on the module should have a provision for opening it for replacing the cable, if required.

(vii) The PV module must use a RF Identification tag (RFID), which must contain the following information:

i. Name of the manufacturer of PV Module
ii. Model or Type Number
iii. Serial Number
iv. Month and year of the manufacture
v. I-V curve for the module
vi. Peak Wattage of the module at 16.4 volts
vii. Im, Vm and FF for the module
viii. Unique Serial No and Model No of the module

Until March 2013, the RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions. **However, from 1st April 2013 onwards RFID shall be mandatorily placed inside the module laminate.**

(viii) **A distinctive serial number starting with NSM will be engraved on the frame of the module or screen printed on the tedlar sheet of the module.**

*****The load voltage and Voc conditions of the PV modules are not applicable for the system having MPPT based charge controller

BATTERY

i. Lead Acid, tubular positive plate flooded electrolyte or Gel / VRLA Type.
ii. The battery will have a minimum rating of 12V, 75 Ah at C/10 discharge rate.
iii. 75 % of the rated capacity of the battery should be between fully charged and load cut off conditions.
iv. Battery should conform to the latest BIS/ International standards.

LIGHT SOURCE

(i) The lamp should be 11 Watt compact fluorescent lamp (CFL) with 4 pins along with proper pre-heating circuit.

(ii) The light output from the lamps should be around 900±5 % lumens.

(iii) The lamp should be housed in an assembly suitable for outdoor use, with a reflector on its back.

No blackening or reduction in the lumen output by more than 10%, should be observed after 1000 ON/OFF cycles - two minutes ON followed by four minutes OFF is one cycle.

ELECTRONICS

i. The total electronic efficiency should be at least 85%.
ii. The inverter should be of quasi sine wave/ sine wave type, with frequency in the range of 20 - 30 KHz.
iii. Electronics should operate at 12 V and should have temperature compensation for proper charging of the battery throughout the year.
iv. The idle current consumption should be less than 5 mA.
v. The PV module itself should be used to sense the ambient light level for switching ON and OFF the lamp.
vi. The PCB containing the electronics should be capable of solder free installation and replacement.
vii. Necessary lengths of wires/cables, switches suitable for DC use and fuses should be provided.

ELECTRONIC PROTECTIONS

i. Adequate protection is to be incorporated under “No Load” conditions e.g. when the lamp is removed and the system is switched ON.
ii. The system should have protection against battery overcharge and deep discharge conditions.
iii. Fuse should be provided to protect against short circuit conditions.
iv. Protection for reverse flow of current through the PV module(s) should be provided.
v. Electronics should have temperature compensation for proper charging of the battery throughout the year.
vi. Adequate protection should be provided against battery reverse polarity.
vii. Load reconnect should be provided at 80% of the battery capacity status.

MECHANICAL COMPONENTS

i. A corrosion resistant metallic frame structure should be fixed on the pole to hold the SPV module.
ii. The frame structure should have provision to adjust its angle of inclination to the horizontal between 0 and 45, so that the module can be oriented at the specified tilt angle.
iii. The pole should be made of Galvanised Iron (GI) pipe.
iv. The height of the pole should be 4 metres above the ground level, after grouting and final installation.
v. The pole should have the provision to hold the luminaire.
vi. The lamp housing should be water proof and should be painted with a corrosion resistant paint.
vii. A vented, acid proof and corrosion resistant metallic box with a locking arrangement for outdoor use should be provided for housing the battery.

INDICATORS

The system should have two indicators, green and red.
The green indicator should indicate the charging under progress and should glow only when the charging is taking place. It should stop glowing when the battery is fully charged.
Red indicator should indicate the battery "Load Cut Off" condition.

QUALITY AND WARRANTY

i. All the components and parts used in the solar street lighting systems should conform to the latest BIS or IEC specifications, wherever such specifications are available and applicable.
ii. **The street lighting system including the battery will be warranted for a period of five years from the date of supply**.
iii. **The PV module(s) will be warranted for a minimum period of 25 years from the date of supply.** The PV modules must be warranted for their output peak watt capacity, which should not be less than 90% at the end of Ten (10) years and 80% at the end of Twenty five (25) years.
iv. The Warranty Card to be supplied with the system must contain the details of the system**.**

OPERATION and MAINTENANCE MANUAL

An Operation, Instruction and Maintenance Manual, in English and the local language, should be provided with the Solar Street Lighting System. The following minimum details must be provided in the Manual:

- Basic principles of Photovoltaics.
- A small write-up (with a block diagram) on Solar Street Lighting System - its components, PV module, battery, electronics and luminaire and expected performance.
- Type, Model number, Voltage & capacity of the battery, used in the system.
- The make and wattage of the CFL used in the lighting system.
- About Charging and Significance of indicators.
- Clear instructions about erection of pole and mounting of PV module (s) and lamp housing assembly on the pole.
- Clear instructions on regular maintenance and trouble shooting of the Solar Street Lighting System.
- DO's and DONT's.
- Name and address of the contact person for repair and maintenance, in case of non-functionality of the solar street lighting system.