Government of India
**MINISTRY OF POWER**

**BUREAU OF ENERGY EFFICIENCY**
Ministry of Power, Govt. of India
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# Standards and Labeling Program for Grid Connected Solar Inverter

# Standards and Labeling Program for Grid Connected Solar Inverter

The Bureau of Energy Efficiency (BEE) is an agency of the Government of India, under the Ministry of Power, established in March 2002 under the provisions of the Energy Conservation Act, 2001. Standards & Labeling (S&L) Program for equipment and appliances was initiated in 2006 with the main objective to provide the consumers an informed choice about the energy and cost-saving potential of the star labeled appliances/equipment being sold in the Indian market.

The program targets display of energy performance labels on high energy end-use appliances and equipment and lays down minimum energy performance standards. This scheme prescribes the criteria for each type of appliance to be rated between 1-star and 5-star, with 1-star being the least efficient and 5-star being the most efficient. Star rating on a product allows a common consumer to compare the operating cost and environmental impact of similar products. This also allows them to make informed choices and see the potential operating costs and greenhouse gas impacts.

The S&L program has covered 35 appliances till January 2024 out of which 16 are under mandatory regime while the remaining 19 are under voluntary regime. The scheme has resulted in overall electricity saving of 81.64 billion units translating to an abatement of 58 million tons of $CO_2$ emission in FY 2022-23.

## Savings from S&L program in FY 2022-2023

**Electricity Saved**
81.64 Billion Units

**Cost Saving**
INR 54,323 Crores

**$CO_2$ Emission Reduction**
58 million Tonnes

## LAUNCH OF S&L PROGRAM FOR GRID CONNECTED SOLAR INVERTER

The renewable energy sector in India is gaining momentum due to strong government backing and improved economic viability. Key drivers of growth in the solar power market include rising investments in renewable energy and supportive policies like the National Solar Mission. Looking ahead, the Hon'ble Prime Minister announced on January 22, 2024, the Pradhan Mantri Suryodaya Yojna, which aims to install rooftop solar systems on one crore households, further boosting solar energy adoption.

To avoid comprehension of inefficient solar PV system, it became essential to optimize the performance of the solar PV system through energy efficiency guidelines or standards. Absence of a regulation or performance standard for Solar PV system has resulted in a challenge to consumers in making an informed choice while purchasing the system. Also, there is an absence of a level playing field in terms of quality products against the cost-competitive substandard ones being sold in the market causing the markets to be flooded with poor quality low-cost Solar PV systems.

The two major components of the solar PV system are Solar Photovoltaic Module and Solar Inverters. To regulate the solar panel market, the Bureau of Energy Efficiency (BEE) has launched Standards & Labeling (S&L) Program for solar PV module on 20$^{th}$ October 2023. To further optimize the efficiency of the solar PV system, BEE is now launching Standards and Labeling program for grid connected solar inverter without storage.

Increasing energy efficiency through Standards & Labeling is cost-effective as energy savings from such initiative are generally assured and comparatively simple to quantify and readily verifiable. Ultimately, the object of Standards & Labeling for grid connected solar inverters is to help the Indian customers to make an informed purchase decision and contribute towards the Government of India's larger goal of reducing the $CO_2$ emission.

## Solar Inverter Market

Government initiatives such as the Smart City project, the development of solar parks and the solar energy subsidy scheme would further accelerate the adoption of solar installations across residential and commercial segments. Grid connected solar inverters dominate the market in 2023 owing to huge adoption across residential and commercial applications, whereas off-grid solar inverters are majorly limited to rural electrification applications.

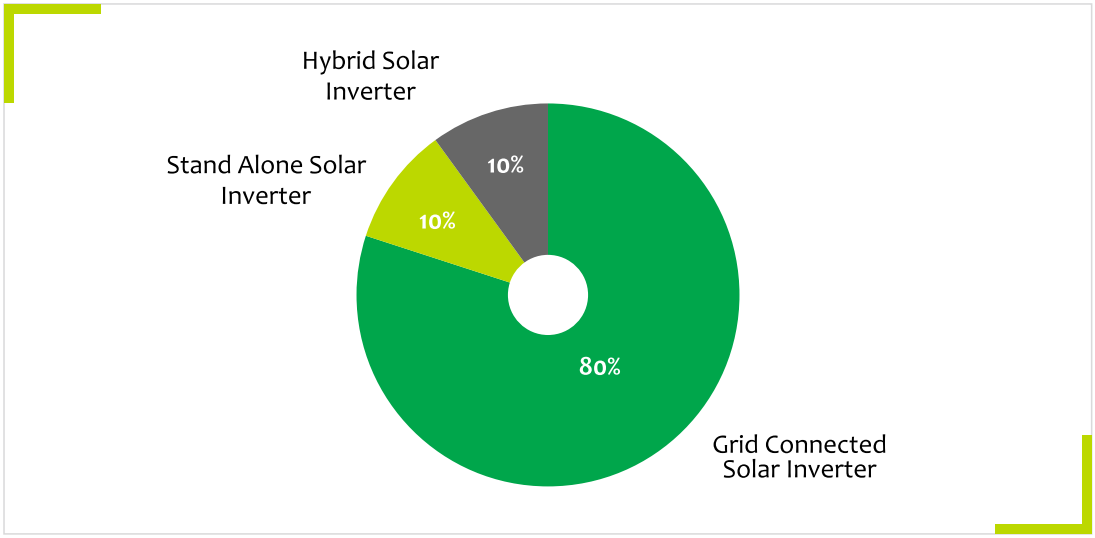



**Figure 1: Market Share of Solar Inverter**

Based on the discussion with manufacturers it is anticipated that, in FY 2022-23, the market size (sales) of all types of solar inverters is close to 2,520 MW. It is also expected that the Indian Solar Inverter market size will grow with a CAGR of 14.4% from 2020 to 2026.

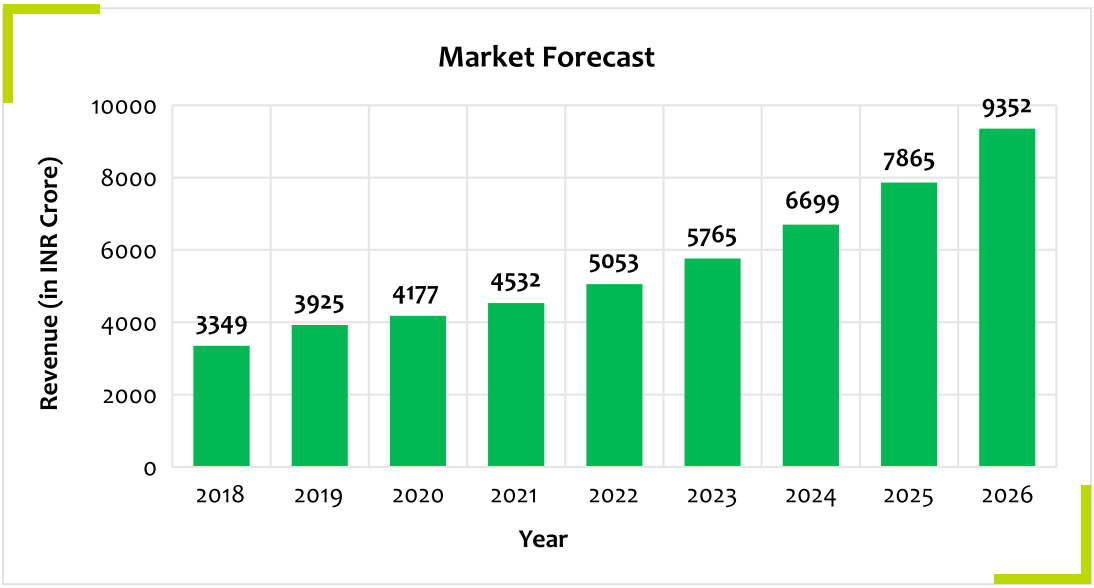



**Figure 2: Solar Inverter Market Forecast till 2026**

## Product Categorization

The Solar Inverters are further categorized based on - system type, technology, rated output power and its application. In terms of system type, the solar inverter is categorized into Grid Connected, Off-Grid and Hybrid Solar Inverters. Based on technology, the grid connected solar inverter is further categorized into micro, string and central inverters.

Based on a comprehensive preliminary market assessment of 450 models from 25 manufacturers it was revealed that nearly 63% market share is of the models with rated output power capacity ranging from 1 kW to 10 kW. There is also a significant market share of solar inverters above 10 kW rated capacity.

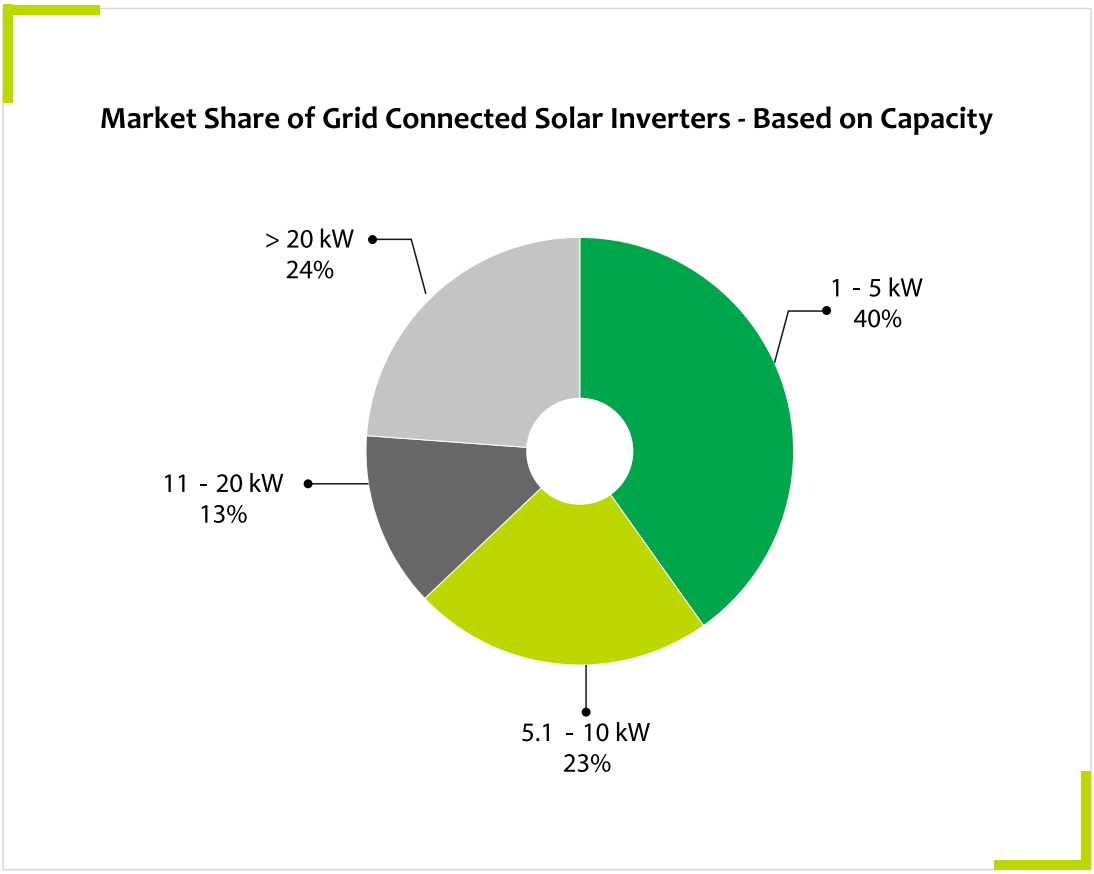



**Figure 3: Market Share of Grid Connected Solar Inverter – Based on Rated Output Power**

## Minimum Energy Performance Standard for Grid Connected Solar Inverters

Majority of the grid connected solar inverters available in India have maximum efficiency lies between 94% to 99%. With the increase in rated capacity the maximum efficiency also increases. Out of 450 models analyzed, 445 models have rated efficiency more than 97%.

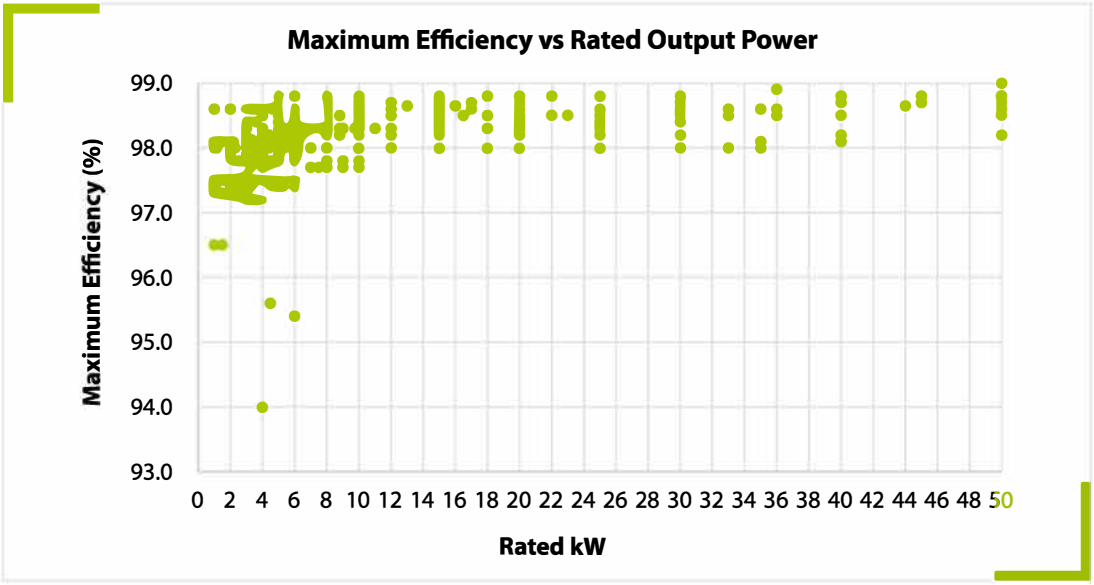



**Figure 4: Maximum Efficiency vs Rated Output Power**

Considering the very narrow bandwidth in maximum efficiency, BEE planned to have an endorsement label for the grid connected solar inverters. To qualify for the Endorsement Label, the grid connected solar inverter must meet the minimum overall efficiency requirement as mentioned in table-1.

**Table 1: Minimum Energy Performance Standard for Grid Connected Solar Inverter**

| Rated Output Power (kW) | Minimum Overall Efficiency Requirement |
|---|---|
| Rated Output Power < 1 | 92% |
| 1 ≤ Rated Output Power < 3 | 93% |
| 3 ≤ Rated Output Power < 5 | 95% |
| 5 ≤ Rated Output Power < 10 | 96% |
| 10 ≤ Rated Output Power < 20 | 97% |
| Rated Output Power ≥ 20 | 98% |

The current MEPS will be valid from 15$^{th}$ March 2024 to 31$^{st}$ December 2025. All tested products must meet the minimum threshold including manufacturing tolerance and other variations.

## Potential Energy Savings and $CO_2$ emission reduction

The implementation of the endorsement label for grid connected solar inverters is anticipated to yield significant energy savings of 21.1 Billion kWh between FY 2024-25 and FY 2033-2034, accompanied by a potential reduction in $CO_2$ emissions amounting to 15.1 Million tons of $CO_2$ in the same time period.

# Schedule - 38

### Grid Connected Solar Inverter

**1. Scope**

1.1 This schedule specifies the requirement for participating in the energy labeling program for both single phase and three phase grid connected solar inverters without storage up to and including 100 kW rated output power being manufactured, imported and sold in India. This schedule specifies the minimum overall efficiency requirement of the inverter based on static maximum power point tracking (MPPT) efficiency measurement and the steady state conversion efficiency prescribed in IS 17980:2022/ IEC 62891:2020.

1.2 The schedule does not cover the dynamic MPPT efficiency.

**2. Reference Standard**

This schedule shall be read in conjunction with the following standards with all amendments.

| Reference Standard | Title of the Standard |
|---|---|
| IS 17980:2022/ IEC 62891:2020 | Maximum Power Point Tracking Efficiency of Grid Connected Photovoltaic Inverters |
| IEC 61836:2016 | Solar photovoltaic energy systems – Terms, definitions and symbols |
| IS 16221-2:2015/ IEC 62109-2: 2011 | Safety of Power Converters for Use in Photovoltaic Power Systems |
| IS 16169:2019/IEC 62116:2014 | Utility - Interconnected Photovoltaic Inverters - Test Procedure of Islanding Prevention Measures |

## 3. Terminology

For the purpose of this schedule, the following definitions shall apply, in addition to those given in IEC 61836, IS 17980/IEC 62891, IS 16221/IEC 62109 and IS 16169/IEC 62116 with as amended from time to time shall apply.

**3.1 Conversion Efficiency –** Ratio of the energy delivered by the device under test at the AC terminal within a defined measuring period to the energy accepted by the device under test at the DC terminal.

**3.2 MPPT Efficiency –** Ratio of the energy drawn by the device under test within a defined measuring period to the energy provided theoretically by the PV simulator at the maximum power point (MPP).

**3.3 Overall Efficiency –** Ratio of the energy delivered by the device under test at the AC terminals within a defined measuring period to the energy provided theoretically by the PV simulator. The overall efficiency ($\eta t$) can also be considered as:

$$\eta_t = \eta_{conv} \times \eta_{MPPTstat} = P_{AC} / P_{MPP,PVS}$$

Where;

$\eta_t$ : Overall Efficiency

$\eta_{conv}$ : Conversion Efficiency

$\eta_{MPPTstat}$ : Static MPP Efficiency

$P_{AC}$ : AC Output Power

$P_{MPP,PVS}$ : MPP Power Provided by PV Simulator

3.4 **Label –** Any written, printed, marked, stamped or graphic matter affixed to or appearing upon, solar inverter.

3.5 **Endorsement Label –** It is mark that defines a group of appliance/equipment as efficient, when they meet minimum energy performance standards (MEPS) specified in the respective appliance/equipment schedule/ gazette notification. Endorsement Label informs prospective purchasers that the product is energy efficient for its category.

3.6 **Models or Family of models –** It is the range of models of a particular brand, to which a single set of test reports is applicable and where each of the models has the same relevant physical characteristics, overall energy efficiency level and performance characteristics.

3.7 **Permittee –** Means a person or agency to whom permission has been granted to affix label under clause 7.

3.8 **Trader or Seller –** In relation to any labeled solar inverter means a person who sells or distributes any such solar inverter and includes the shopkeeper, trader, manufacturer, and permittee who has been given permission to affix label on such Grid Connected Solar Inverter.

## 4. Testing Guidelines

**4.1** Performance testing parameters: For the purpose of determining the minimum overall efficiency criteria, the Grid Connected Solar Inverter shall comply the requirements of all the tests defined in Table-1.

**Table 1: Performance Testing Parameters**

| S. No. | Nature of Test | Test Standards and Clause References |
|---|---|---|
| 1 | Static MPPT efficiency | Clause 4.1 of IS 17980:2022/ IEC 62891:2020 |
| 2 | Conversion efficiency | Clause 3.4.2 of IS 17980:2022/ IEC 62891:2020 |
| 3 | Overall efficiency at Standard Test Conditions (STC) | Clause 5 of IS 17980:2022/ IEC 62891:2020 |

## 5. Qualification Criteria

To qualify for award of Endorsement Label, the grid connected solar inverter shall meet the minimum overall efficiency requirement as mentioned in Table-2.

**Table-2 Minimum Overall Efficiency Requirement for Grid Connected Solar Inverter**

| (Valid from 15th March 2024 to 31st December 2025) | |
|---|---|
| Rated Output Power (kW) | Minimum Overall Efficiency Requirement |
| Rated Output Power < 1 | 92% |
| 1 ≤ Rated Output Power < 3 | 93% |
| 3 ≤ Rated Output Power < 5 | 95% |
| 5 ≤ Rated Output Power < 10 | 96% |
| 10 ≤ Rated Output Power < 20 | 97% |
| Rated Output Power ≥ 20 | 98% |

Only BIS certified solar inverters complied with IS 16221-2:2015 are eligible to take part in the BEE's Standards and Labeling program.

There shall be no negative tolerance in the minimum overall efficiency requirement criteria for obtaining the BEE's endorsement label. All tested products shall meet the minimum threshold including manufacturing tolerance and other variations.

## 6. Test Report

The result of the tests carried out in laboratory accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL) or any other Calibration Agency who are having Mutual Recognition Arrangement (MRA) with International Laboratory Accreditation Cooperation (ILAC) or Asia Pacific Accreditation Cooperation (APAC) or equivalent bodies for ensuring consistency in quality of the equipment as well as the scope of relevant Indian standards shall be reported in the prescribed format mentioned in the Annexure-I appended to this Schedule. Accreditation of the test labs should be based on IS 17980:2022/IEC 62891: 2020.

## 7. Label Design and Manner of Display

### 7.1 Placement of Endorsement Label

On every grid connected solar inverter, Endorsement label shall be displayed at the point of sale and such label shall be affixed on the grid connected solar inverter in the following manner:

a. Self-adhesive label affixed on the front side of the top right corner of the grid connected solar inverter.

b. Self-adhesive label affixed on the front side of the top right corner of the carton box.

### 7.2 Material and Shape

The label shall be of non-perishable material and shall be of durable cardboard or be self- adhesive and shall be cut to one of the outlines.

### 7.3 Sample Label

A typical sample of the printed endorsement label and the color, shape and design to be affixed on each grid connected solar inverter shall be as shown in ***Annexure-II.***

### 7.4 Particulars to be displayed on the Endorsement Label

On every Solar Inverter (approved for endorsement label), the following particulars shall be displayed on its Endorsement label, namely:

a) Product Name: Solar Inverter
b) Name of manufacturer or importer or brand
c) Model Name/Number
d) Year of Manufacturing
e) Rated Capacity (kW)

## 8. Fees

a) The applicant shall deposit a security fee of INR 1,00,000/- (Rupees One Lakh only) for each registration as security deposit. However, applicants registered as small-

   scale industries (SSI units), shall deposit INR 25,000/- (Rupees Twenty-Five Thousand only) provided that they submit the valid SSI registration certificate.

b) Application fee payable on application for each model seeking permission to affix label is INR 2000/- (Rupees Two Thousand only). This fee is waived off till 30.09.2024.

c) No application fee is payable on application for renewal of permission to affix label on the model.

d) Labeling fee for affixation of Endorsement label on each solar inverter will be Rs. 5/- per kW (Rupees Five per kW only). This fee is waived off till 31.03.2025.

## 9. Check Testing

**a)** Sample testing for compliance of solar inverter covered under the S&L scheme with respect to BEE performance standards may be carried out in laboratories that are either BIS recognized/ NABL accredited.

**b)** The samples will be picked up by BEE or its designated agency for testing as per the following sampling plan:

1. Samples will be picked up at random from manufacturer's authorized dealer/retailer/e-market platform.
2. In case the sample drawn for the first check testing fails, the Bureau or its designated agency shall conduct a second check testing for which it shall buy twice the quantity of samples for the same model. If the first set of sample fails, only then second check testing will be done.
3. The permittee/user of the label would be accordingly informed about the failure of the first check testing and shall be advised to deposit the cost of the samples, cost of check testing and transport for the second check testing in advance.

4. If permittee fails to deposit/pay the expenses, Bureau shall continue the verification by check testing and stop further processing of application received for new appliance/ equipment of the respective permittee.

5. Second set of samples will be picked up at random from the market for second check testing, and both samples must pass the test.

6. BEE or its designated agency shall inform the date of second check testing to the permittee to witness the second check testing. If the permittee is unable to witness the testing, the Bureau shall proceed with testing in the presence of BEE/ Designated Agency personnel and the test result shall be binding on the permittee.

7. If any one of the samples fail during second check testing, the solar inverter model will be considered as non-compliance with the prescribed

BEE standards and Bureau/Designated Agency shall proceed with the following actions:

- Direct the permittee, under intimation to all the State Designated Agencies, that the permittee within a period of two months from the date of issuance of such intimation, shall-
  - Withdraw all the stocks from the market to comply with the directions of the Bureau; and
  - Remove Endorsement Label from all stocks or rectify the defects and deficiencies found during testing from the existing and new stock;

- Publish, for the benefit of the consumers, the name of the permittee, brand name, model name or model number, logo and other specification in any national or regional daily newspaper and in any electronic or in any other manner as it deems fit within three months;
- The permittee within ten days of the conclusion of the period of two months from the date of issuance of intimation shall send the action taken report to the Bureau/Designated Agency with respect to action taken in compliance with the direction.

**c)** Every permittee, trader and seller shall comply with other terms and conditions as specified under Disseminating Star Labeling in Household Appliance (DISHA) - Operation Manual on Standards and Labeling program.

# ANNEXURE - I

**Form for Reporting Test Results**

## 1. General Information

| | | | |
|---|---|---|---|
| Laboratory Name | | | |
| Address | | | |
| Date of Receipt | | | |
| Lab accreditation number and validity period | | | |
| Test standard followed | | | |
| Test Report No. | | Date of testing | |
| Tested by | | Reviewed by | |

## 2. Details of the Sample Tested

| | |
|---|---|
| Brand Name | |
| Model Name | |
| Model No. | |
| Month and Year of manufacturing | |
| Manufacturer Serial Number (if any) | |
| Rated AC power (kW) | |
| Rated output voltage (V) | |
| Overall efficiency (%) | |

## 3. Test condition details

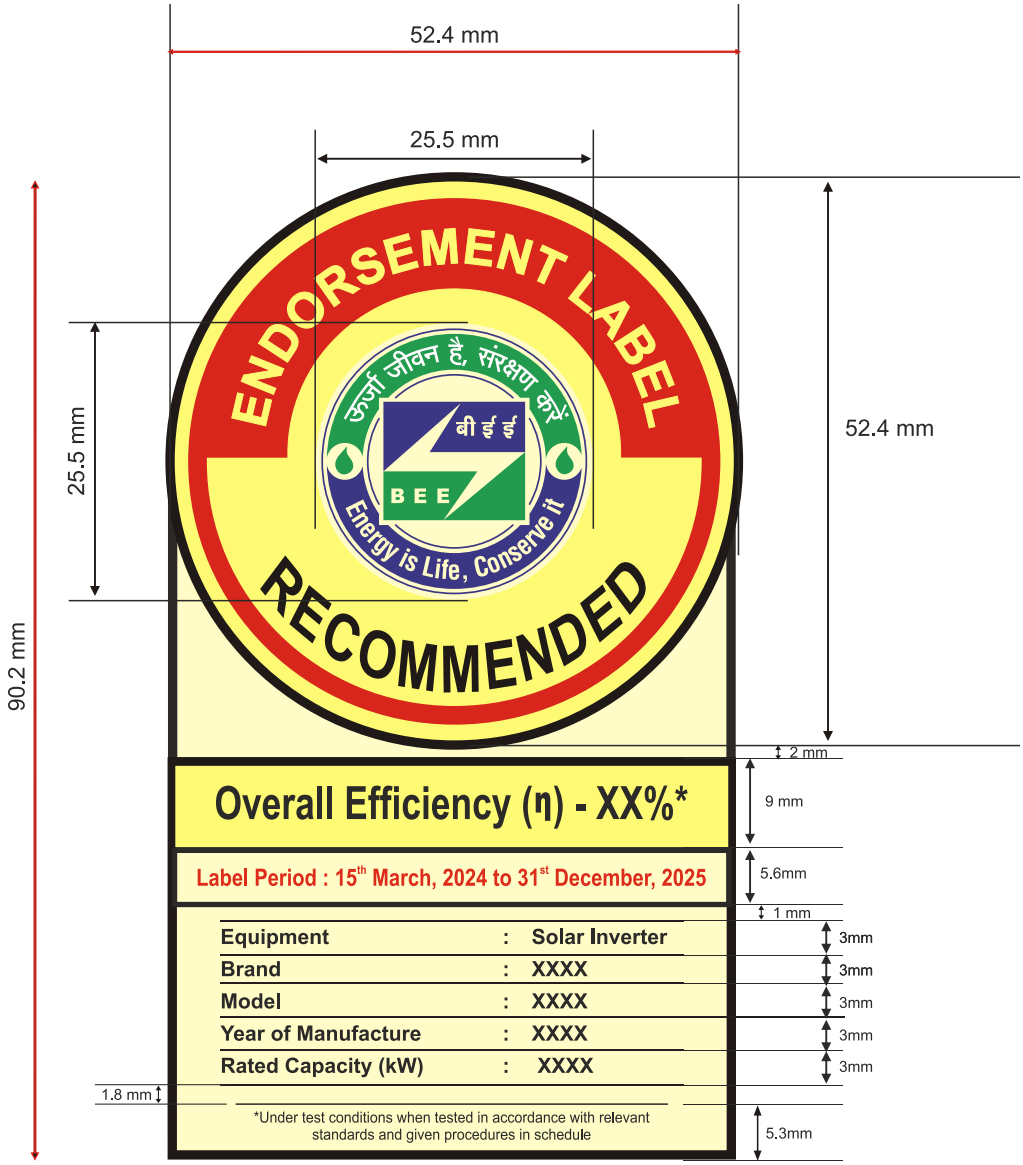
| | |
|---|---|
| Ambient Temperature (°C) | |
| Output voltage (V) | |
| Output frequency (Hz) | |
| Input voltage while testing (V) | |

## 4. Test results

| | |
|---|---|
| Static MPPT efficiency (%) | |
| Conversion efficiency (%) | |
| Overall efficiency @ Standard Test Conditions (STC) (%) | |

# ANNEXURE - II

1. **Material & Dimension of label:** The label shall be self–adhesive and shall be designed as set out in sample label.

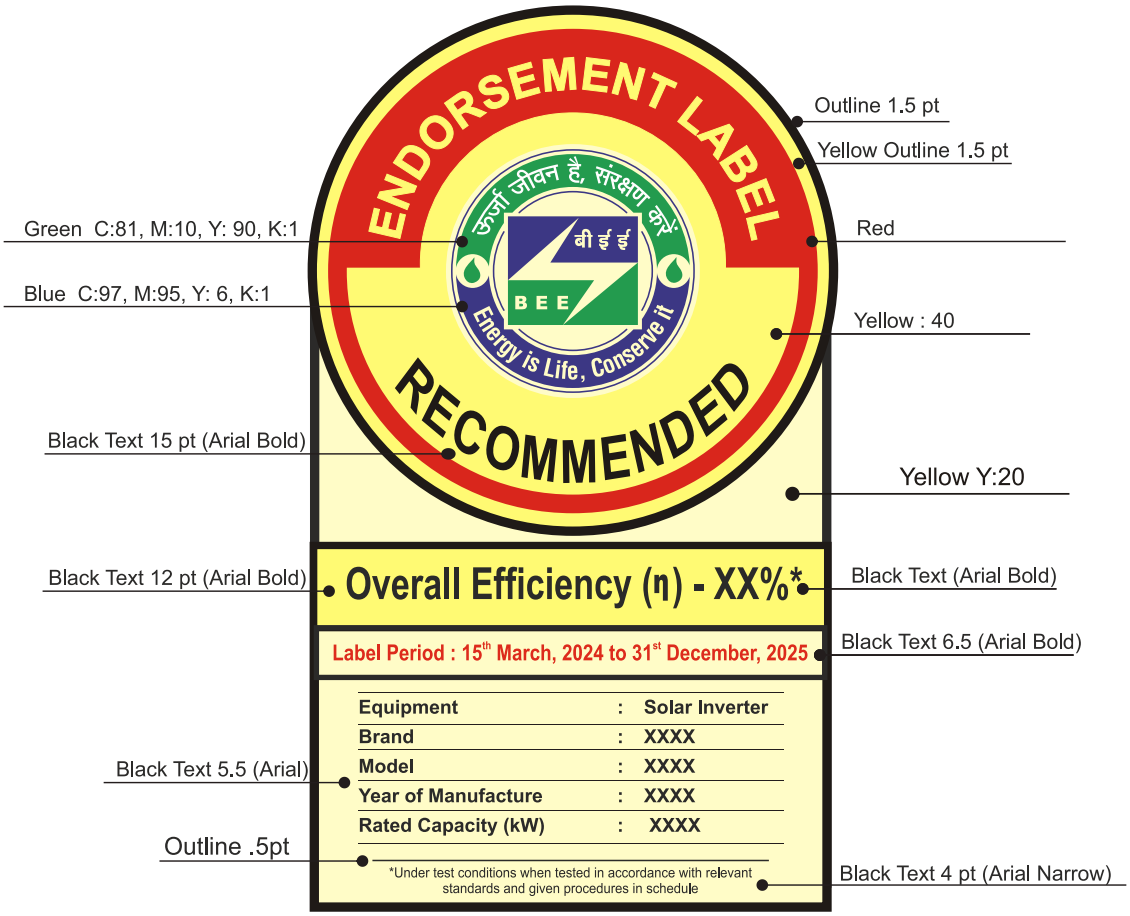


2. **Color scheme of label:** The label shall be printed as per the following specification in the following colors on a white background:

   a. Red: Pantone warm red
   b. Yellow: Pantone 116
   c. Black: Pantone Black
   d. Green: Pantone 340

The following color scheme for Bureau's logo, namely:

   a. BLUE – Hue(H)-2390 Saturation(S):64% Brightness(B):59%
   b. Luminance or lightness(L) :28, chromatic components a:24 b:54
   c. Red(R):54 Green(G):55 Blue(B):151
   d. Cyan(C):97% Magenta(M):95% Yellow(Y):6% Black(K):1%
   e. Web color code - #363797
   f. GREEN – Hue(H)-1500 Saturation(S):10% Brightness(B):67%
   g. Luminance or lightness(L) :61, chromatic components -a: 53 b:32
   h. Red(R):0 Green(G):170 Blue(B):87
   I. Cyan(C):81% Magenta(M):10% Yellow(Y):90% Black(K):1%
   j. Web color code - #00AA56


ENDORSEMENT LABEL
ऊर्जा जीवन है, संरक्षण करें
बी ई ई
BEE
Energy is Life, Conserve it
RECOMMENDED
Overall Efficiency (η) - XX%*
Label Period : 15th March, 2024 to 31st December, 2025
Equipment : Solar Inverter
Brand : XXXX
Model : XXXX
Year of Manufacture : XXXX
Rated Capacity (kW) : XXXX
*Under test conditions when tested in accordance with relevant standards and given procedures in schedule
Outline 1.5 pt
Yellow Outline 1.5 pt
Green C:81, M:10, Y: 90, K:1
Red
Blue C:97, M:95, Y: 6, K:1
Yellow : 40
Black Text 15 pt (Arial Bold)
Yellow Y:20
Black Text 12 pt (Arial Bold)
Black Text (Arial Bold)
Black Text 6.5 (Arial Bold)
Black Text 5.5 (Arial)
Outline .5pt
Black Text 4 pt (Arial Narrow)

3. **Sample label:** An example of a printed endorsement label for a grid connected solar inverter is shown in following label.

## BEE's Key Endeavours

Standards & Labeling Program (S&L)

Demand Side Management (DSM)

Energy Conservation Building Code (ECBC)

Perform, Achieve and Trade (PAT)

Energy Efficiency in Micro Small and Medium Enterprises (MSMEs)

Electric Vehicle Energy Efficiency

## You're welcome to reach us at: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