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Institute for Applied Sustainability to the Built Environment

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Nominal power of PV modules : a review .

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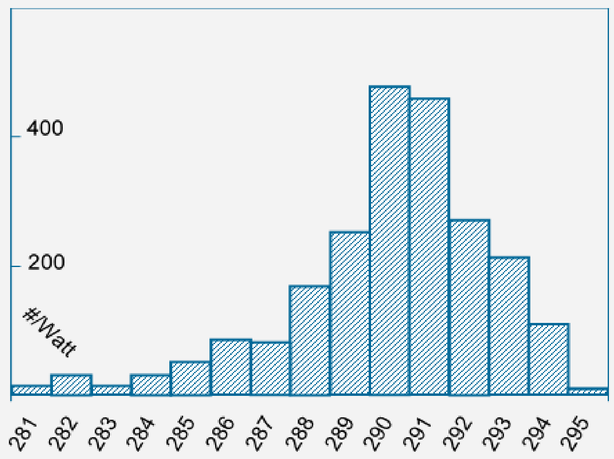
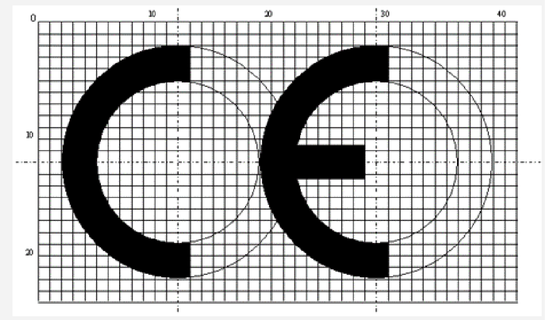
ABSTRACT

With the increasing industrial production of photovoltaic modules and the installations of PV plants reaching the impressive amount of 500 GW of total installed capacity in 2019, the PV market has changed dramatically. Through the years the situation has shifted from a status where the PV module classes were determined with tolerance ranges between - 10% / +10 % (20% total width), with guaranteed lifetime of 20 years at 80% of the nominal power, to present datasheets, where high efficiency modules of 300 W are now classified in bins of total width of only 1% (-0/+3W), an accuracy that even the best calibration laboratories can't reach, with lifetimes extended to 30 years at 85% nominal power.



Label normative definition

- The requirements for the marking of a photovoltaic module are included in the **IEC 61730-1** norm "Photovoltaic (PV) module safety qualification Part 1: Requirements for construction"
- Together with the **IEC 61730-2** "Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing", is the base for the **mandatory European mark CE**, for compliance of the electrical products to the Low Voltage directive 2014/35/EU
- Both norms are in fact included as harmonised standards in the Official Journal of the European Union for the "making available on the market of electrical equipment designed for use within certain voltage limits".
- In other words, **parts which are produced according to one or multiple harmonised standards, published in the EU Official Journal, are considered to meet the the basic safety and health requirements set by the standard(s) itself**
- CE marking is not mandatory in Switzerland, it is accepted, and the Art.5 of Ordinance on electrical low-voltage equipment **(NEV; SR 734.26) practically transposes the EU directive 2014/35/EU into the Swiss law**.
- Other norms, detailing requirements for the PV module label are the **IEC 61215-1** and **EN 50380**; further to the list of parameters that must appear on the label, they set **the best practice in order to check properly the correct values of the nominal power**



Verification of the nominal power

- What is the best practice in order to check properly the correct values of the nominal power? Which are the Pass/Fail criteria?
- Norm **EN 50380 contains a best practice procedure, based upon the criteria set in IEC 61215-1, which defines the verification of electrical characteristics of a PV module:**
- The sample of modules to be tested shall be fully representative of the production lot, including variations in the Bill Of Materials (BOM)
- **All modules shall be stabilized** (according to IEC 61215-2, general, or technology specific procedure detailed in 61215-1 and similar) .

- After the stabilization procedure **all modules shall be within the power rating of the name plate Pm (NP) including stated measurement uncertainty m1**.

Therefore, the following criterion shall be met:

$$P_{max}(Lab)\cdot\left(1+\frac{|m_1|[\%]}{100}\right)\geq P_{max}(NP)\cdot\left(1-\frac{|t_1|[\%]}{100}\right)$$

Pmax (Lab): Measured maximum STC power of each module in the stabilized state
Pmax (NP): Maximum rated nameplate power of each module without rated production tolerances Measurement uncertainty in % of laboratory for Pm., (expanded combined uncertainty (k = 2), ISO/ IEC Guide 98-3)
m1: Measurement uncertainty in % of laboratory for Pm.,[…]
t1: Manufacturer's rated lower production tolerance in % for Pm.

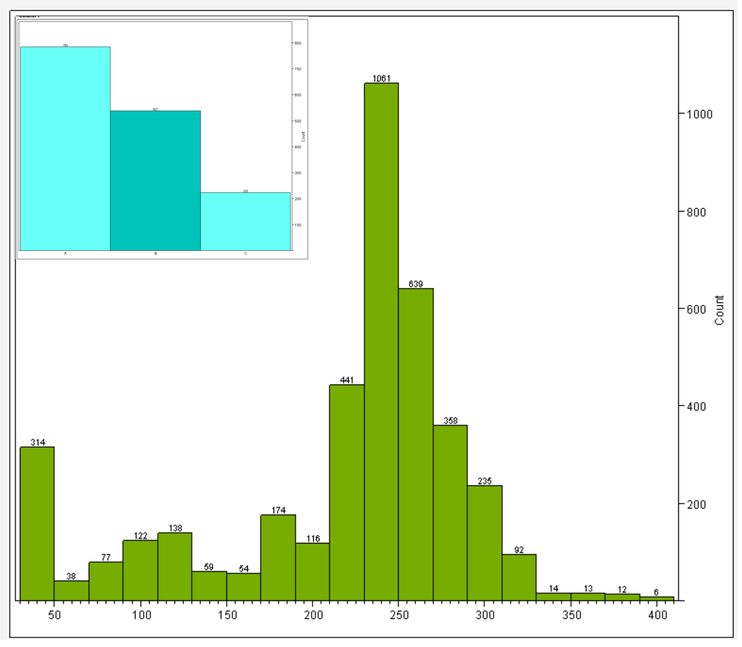
For Pmax (Lab) the following criterion shall apply

$$\overline{P}_{max}(Lab)\cdot\left(1+\frac{|m_1|[\%]}{100}\right)\geq P_{max}(NP)$$

$\overline{P}$max(Lab) ; arithmetic average of the measured maximum STC power of the modules instabilized condition.
For multiple bins of power classes this formula shall be applied to each power class under investigation

11 years of measurements at SUPSI PVLAB (2009-2020)

- 8044 flasher measurements
- 5848 modules of all technologies
- 5027 Silicon modules

Of the 1547 silicon technology classified solar modules:

- 783 modules in class A (51%) , according to the label
- 537 modules in class B (35%) , not according to the label, but within meas. tolerance
- 222 modules in class C (14%) , not according to the label, out of tolerance