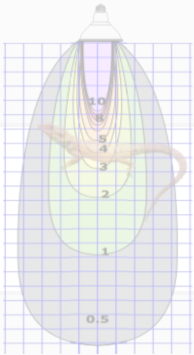
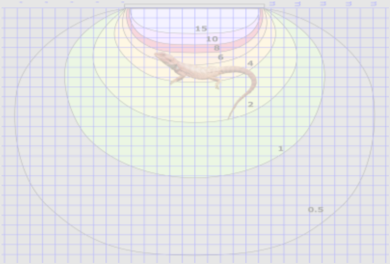
Introducing a mathematical method to use a Solar Power Meter for non-solar spectra





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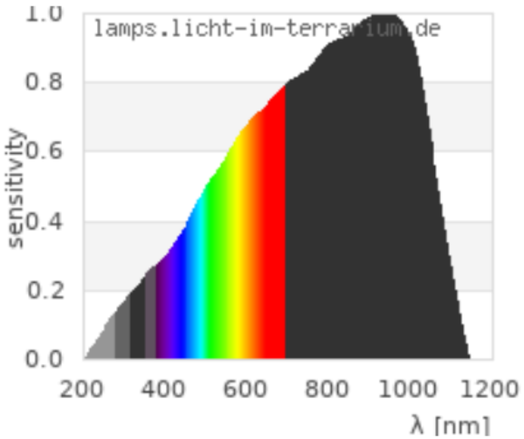
Physically the Solar Power Meter works by converting light into current in a **photo diode**

- Heart of the Power Meter is a Silicon photodiode
- This is underneath a diffusor cap, that makes sure, that light from all directions reach the sensor
- The Silicon photodiode generates an electrical current, when light reaches it
- The electronics inside the meter convert this current into a number
- During the calibration process, the factor or gain is determined, which is needed to multiply the electrical current so that the correct reading is displayed for the calibration light source.

For different light spectra, it makes sense to describe the function by a **formula**

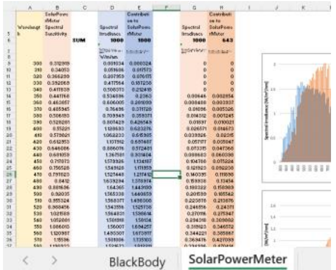
- Not all wavelengths contribute equally to the current of the photodiode. Some wavelengths are not recognized by the photodiode at all.
- A typical response of a Silicon photodiode is shown on the right, it stretches from 300 to 1100 nm with a peak around 950 nm



- The number displayed by the meter can be calculated from the light spectrum S and the Power Meter response A as:

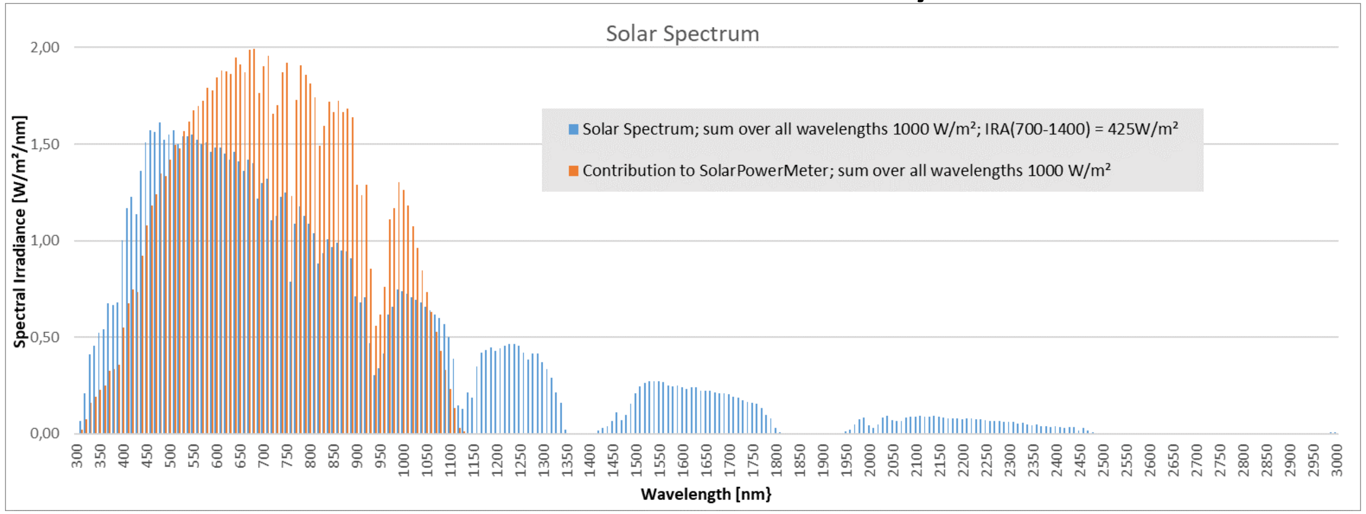
$$\int S(\lambda) \cdot A(\lambda)\, \mathrm{d}\lambda$$

  - $S(\lambda) \cdot A(\lambda)$ means: For every wavelength λ the intensity of the light $S(\lambda)$ and the response strength of the meter $A(\lambda)$ are multiplied
  - $\int S(\lambda) \cdot A(\lambda)\, \mathrm{d}\lambda$ means: Then all contributions to the meter are summed up
- I provide an Excel file to do the calculation

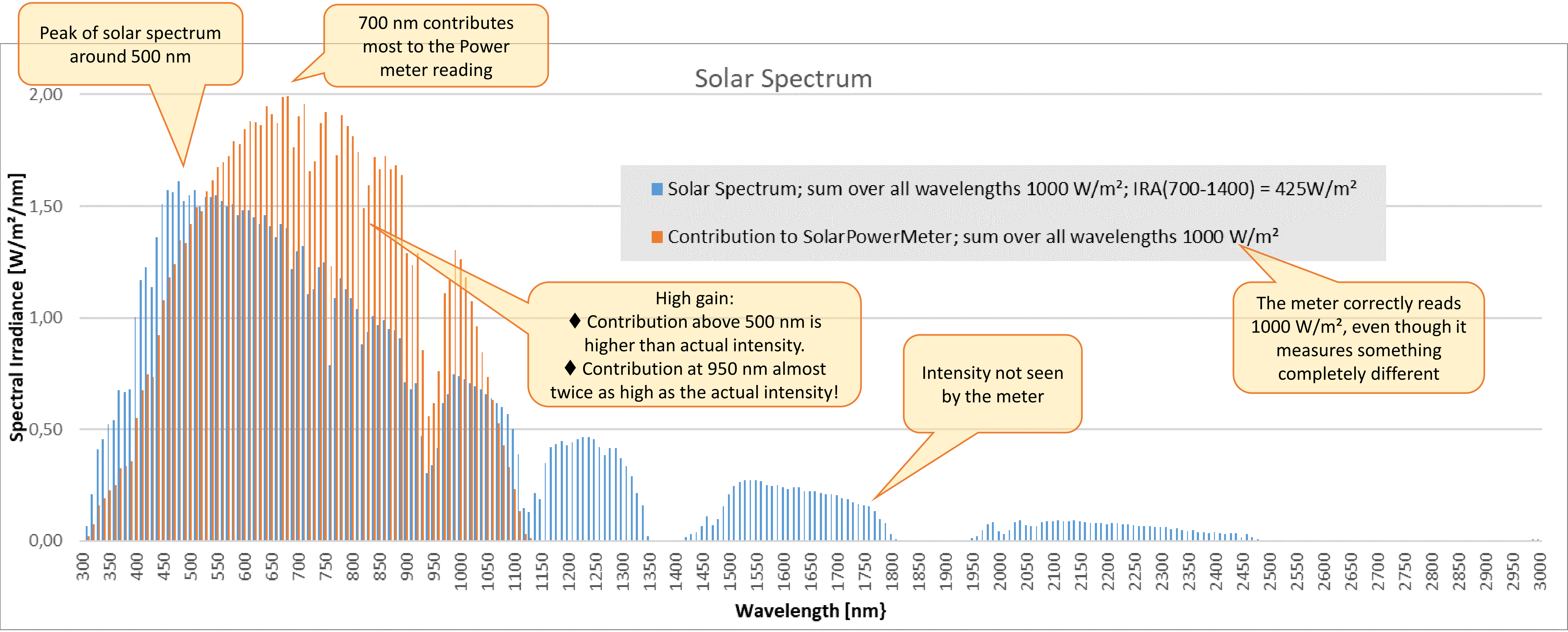


Example: **Sunlight** – even though meter sees only part, calibration ensures correct reading

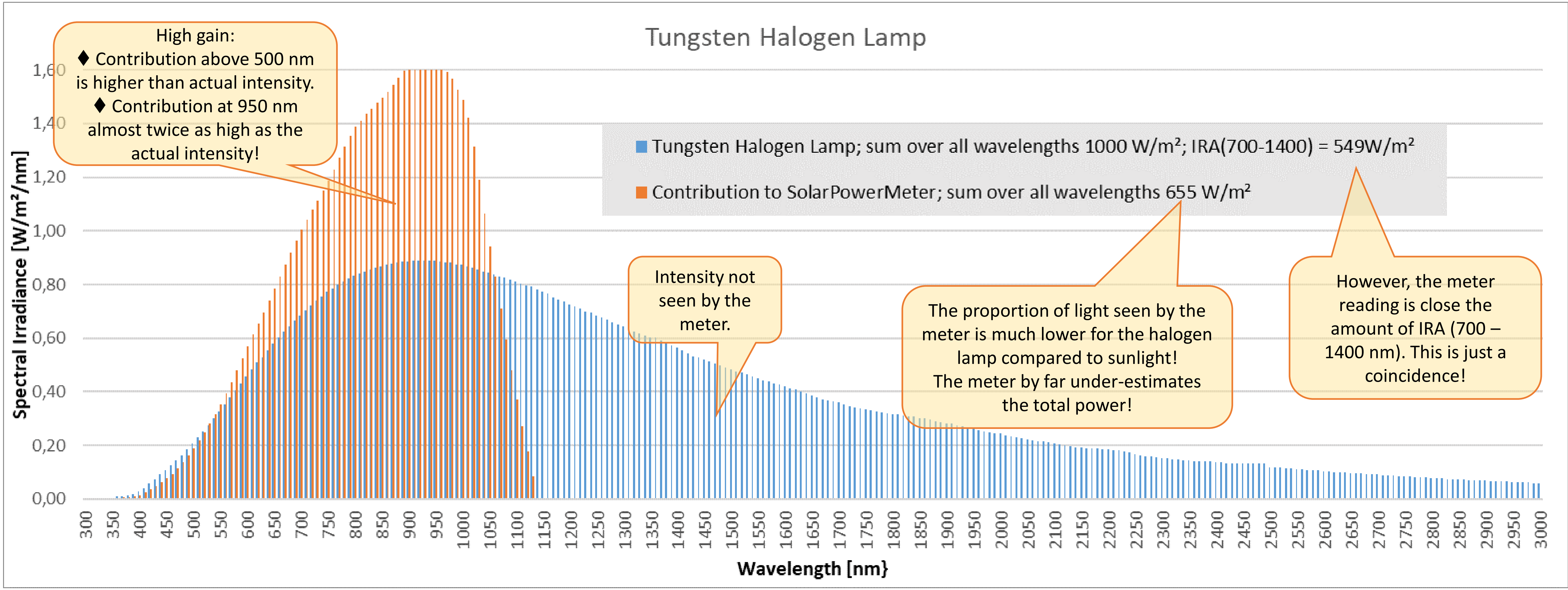
- The solar spectrum has a total power density of 1000 W/m²
- The Silicon photodiode does not see the full spectrum, it only responds to 400 – 1100 nm
- While the solar spectrum has intensities at 1200 nm and 1600 nm, the meter does not see that
- While the solar spectrum has its peak intensity around 500 nm, the wavelength contributing most to the Power Meter reading is at 700 nm
- However, during calibration, the gain of the diode has been increased by almost a factor of 2 at around 950 nm
- Thus, the sum over all contributions to the Power Meter equals 1000 W/m² - This is ensured by the calibration process



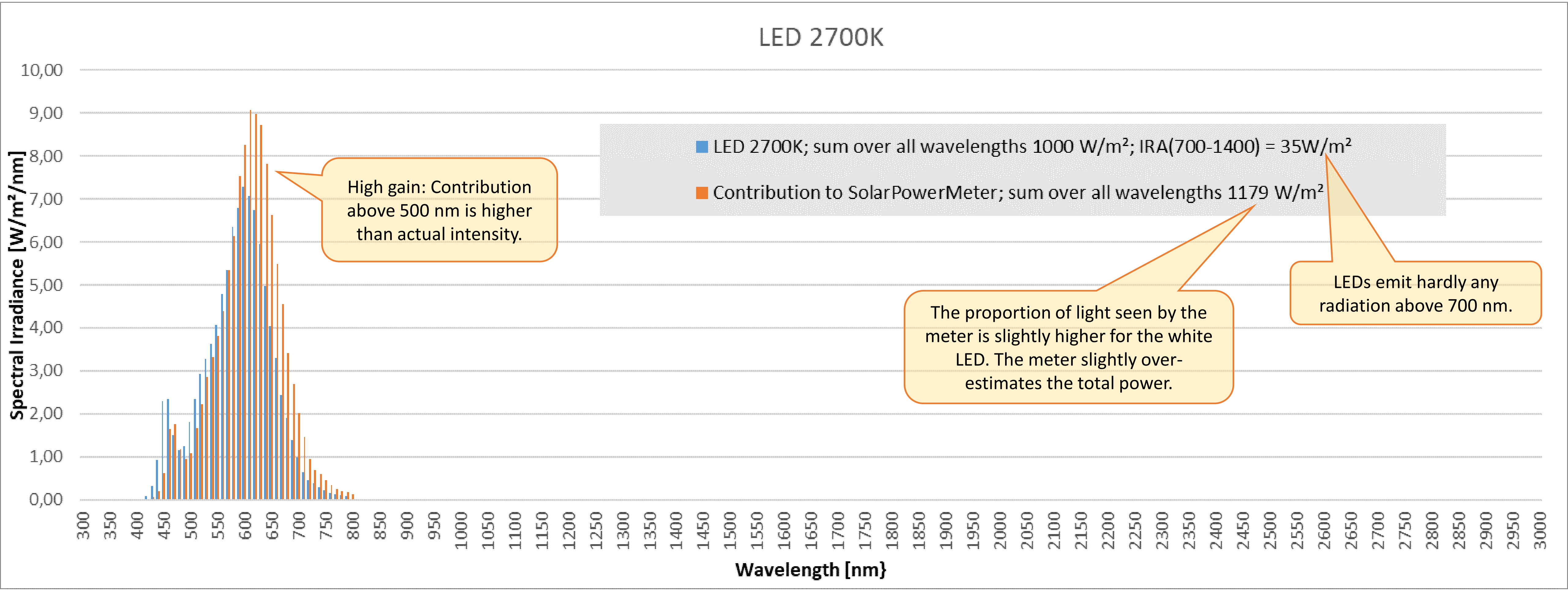
Example: **Sunlight** – even though meter sees only part, calibration ensures correct reading



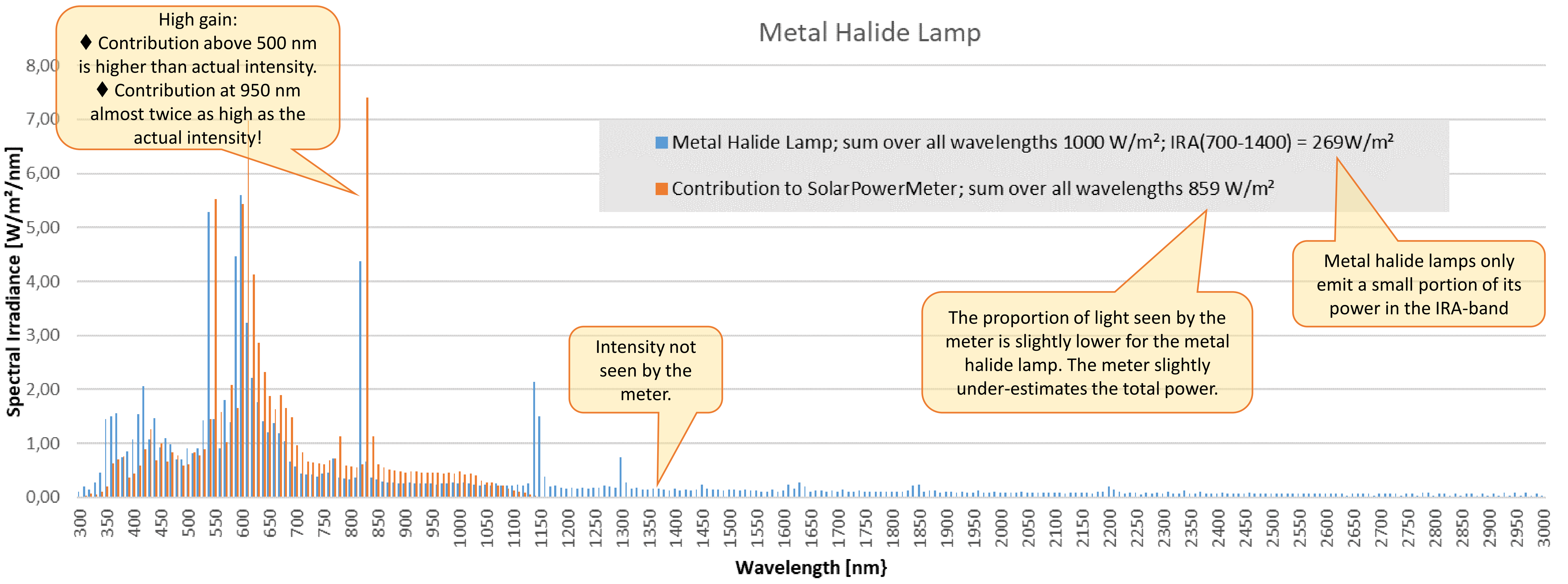
Example **Tungsten Halogen**: calibration no longer works, but by chance the reading matches IRA



Example **White LED (2700 K):** The meter reading is slightly higher than the acutal power



Example **Metal Halide**: The meter slightly under-estimates the total power



Example **Red/IR LED**: lamp emits only in the high-gain-region, thus the meter over-estimates power