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PV MODULE LIFE TIME FORECAST AND EVALUATION

Correlation of climatic degradation factors as a basis for typical load definition

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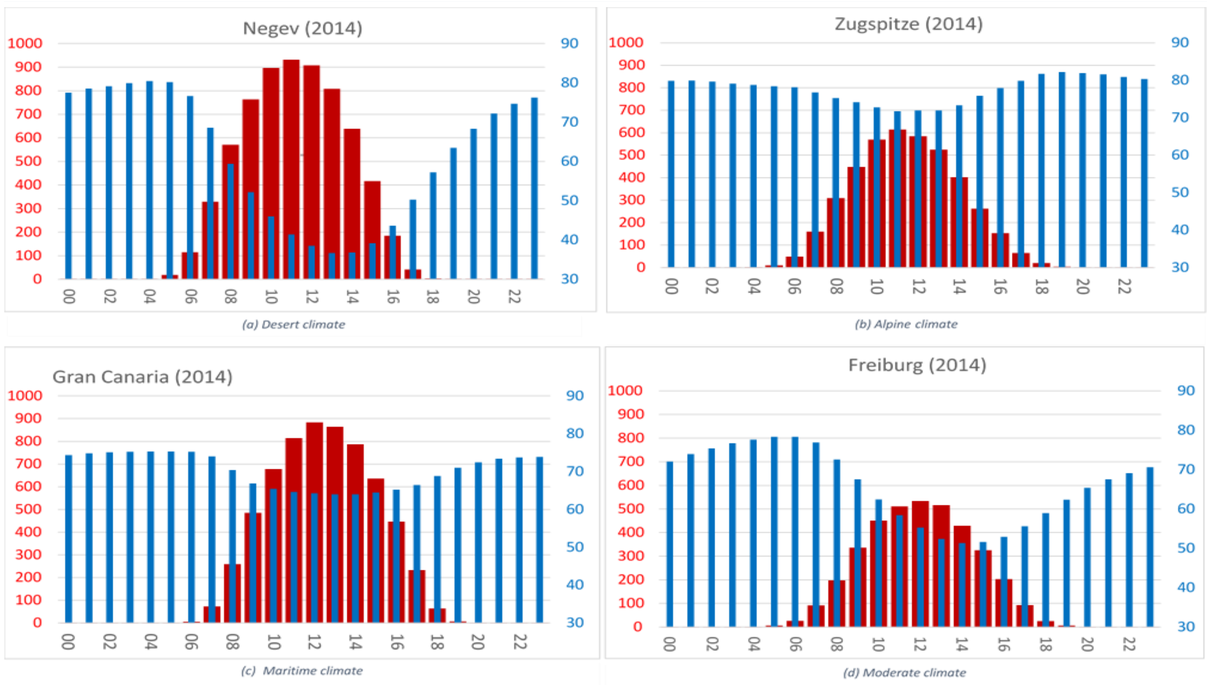
MOTIVATION

The climatic factors below are contributing significantly in PV degradation.

- **(G)** Global irradiation
- **(UV)** UV irradiation
- **(Tamb)** Ambient temperature
- **(TC)** Temperature cycles
- **(RH)** Relative humidity
- **(WS)** Wind speed
- **Soiling**: dust, sand and organic matter.
- **Salt**

The objective is to correlate these factors between each-other. This way, often non measured factors like UV can be calculated based on other factors.

G AND RH COMPARISON IN FOUR CLIMATES



(a) Desert climate *(b) Alpine climate* *(c) Maritime climate* *(d) Moderate climate*

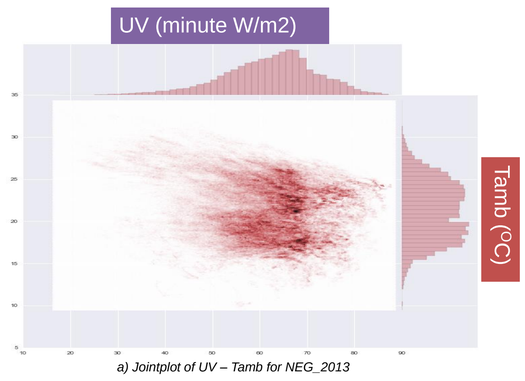
Hourly average values taken through one year. G (0-1000 [W/m^2]) and RH (30 – 90 [%]) values per hour are in an inversely proportional relationship.

G → Tamb → RH

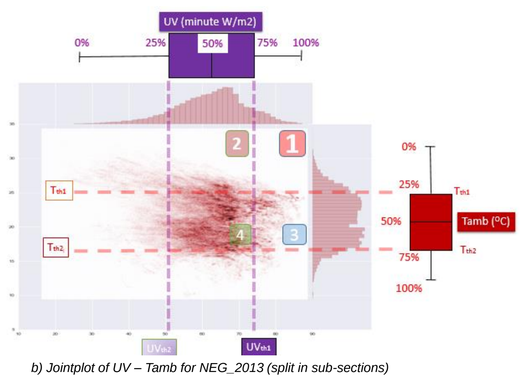
RH in the desert is dropping significantly during midday hours in comparison to alpine and maritime where the RH drop is smaller.

CLIMATIC SUB-ZONES (next steps)

a) Combined frequency distributions of climatic factors by two (UV-Tamb, RH-Tamb)
b) Splitting each distribution in 3 sections based on frequency. (0 – 25 - 75 - 100) %



a) Jointplot of UV – Tamb for NEG_2013



b) Jointplot of UV – Tamb for NEG_2013 (split in sub-sections)

Each sub-zone:
- Has a different significance/ weight to the PV modules degradation.
- Determines how much time/ the modules spend under those conditions.

Assuming high T is more critical than high UV
1. Very critical (high T, high UV/RH)
2. Critical (high T, medium UV)
3. Less critical (medium T, high UV/RH)
4. Non critical (medium T, medium UV)

RERERENCES

M. Köntges et. al, "IEA PVPS - Assessment of Photovoltaic Module Failures in the Field“, (2017)

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FOUR DIFFERENT CLIMATIC LOCATIONS

- 1. Gran Canarias (**GC** - Maritime)
- 2. Zugspitze (**UFS** – Alpine)
- 3. Negev (**NEG** – Desert)
- 4. Freiburg (**Freib** – Moderate)

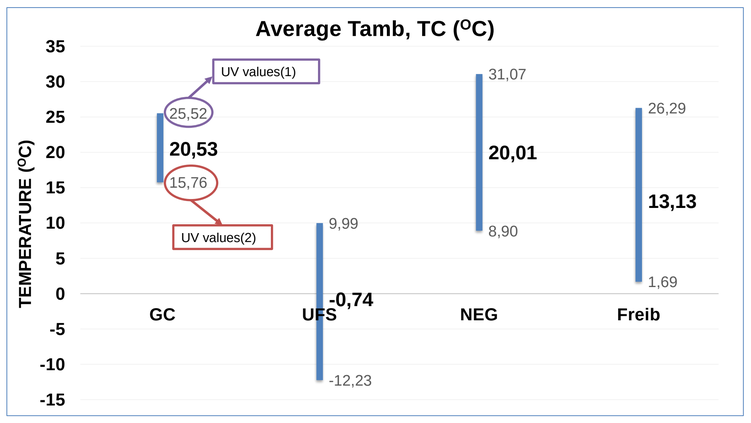
Climatic conditions in these locations vary significantly, thus they were chosen. Minute measurements are conducted of the climatic factors of interest **G, RH, Tamb, UV, Ws.** This location diversity can provide useful insights about these factors' impacts.

PV sites locations

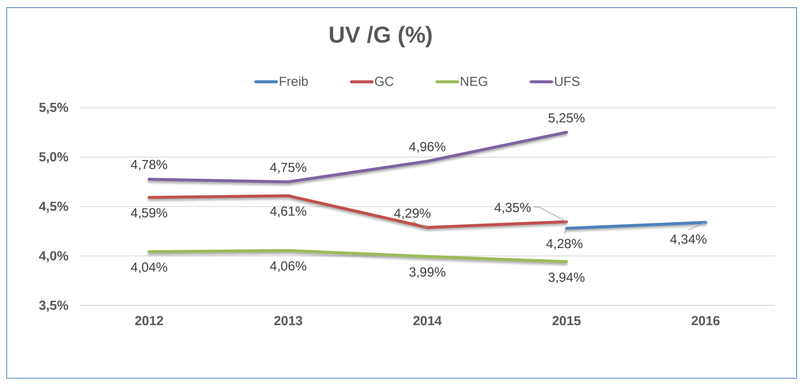
Tamb DISTRIBUTION AND UV VALUES

Average ambient temperature of:
- Highest 16% values
- All yearly values
- Lowest 16% values

UV dosage is different depending on the temperatures values there are in each climate.



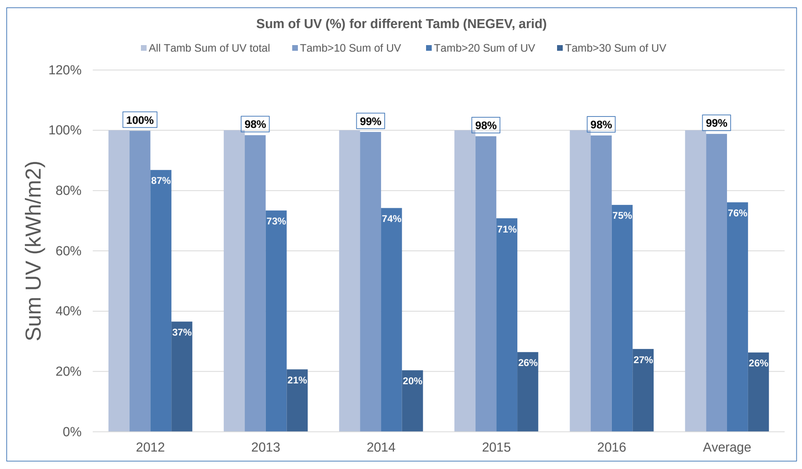
ULTRA VIOLET / GLOBAL IRRADIATION RATIO



Site	Average G	Average UV	Average UV/G
GC	258.40	11.52	4.46%
UFS	190.15	9.39	4.93%
NEG	274.15	10.99	4.01%
Freib	153.13	6.80	4.31%

Ultra Violet **(UV)** irradiation is a small part of the Global irradiation **(G).**
As a rule of thumb UV/G ratio is around 5%.

UV DOSAGE FOR DIFFERENT Tamb



UV dosage is measured for different temperatures values and compared as a percentage of the total.

NEGEV	All Tamb	Tamb>10	Tamb>20	Tamb>30
	Total UV (kWh/m2)	Sum UV	Sum UV	Sum UV
2012	99,2	100%	87%	37%
2013	99,7	98%	73%	21%
2014	96,7	99%	74%	20%
2015	92,5	98%	71%	26%
2016	93,2	98%	75%	27%
Average	96,3	99%	85%	26%

eg. UV_{total} =100% for Tamb>20°C →
$UV_{Tamb>20°C}$ = 0.85 *UV_{total}

COMMUNICATION

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