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PV MODULE LIFE TIME FORECAST AND EVALUATION

Impact of climate on the PV performance and degradation in Europe

J. Ascencio-Vásquez, K. Brecl and M. Topič
LPVO, Faculty of Electrical Engineering, University of Ljubljana, Slovenia

OVERVIEW OF THE RESEARCH

- Methodologies to estimate degradation rates and reliability indicators for PV modules and materials are under study. This research aims to identify the main climate degradation factors, quantify their impact on performance and further on, establish climate zones depending on climate stresses for PV modules and PV systems.

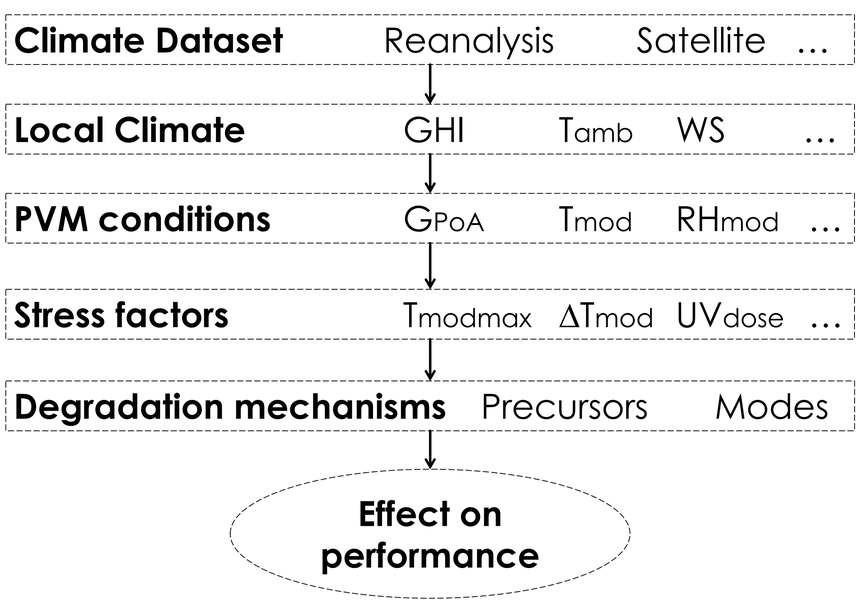
- In this work, we consider the use of an analytical model to estimate the degradation of PV modules in terms of combinatory stresses (temperature, humidity and UV irradiation) in Europe.

ANALYTICAL APPROACH FOR PV DEGRADATION

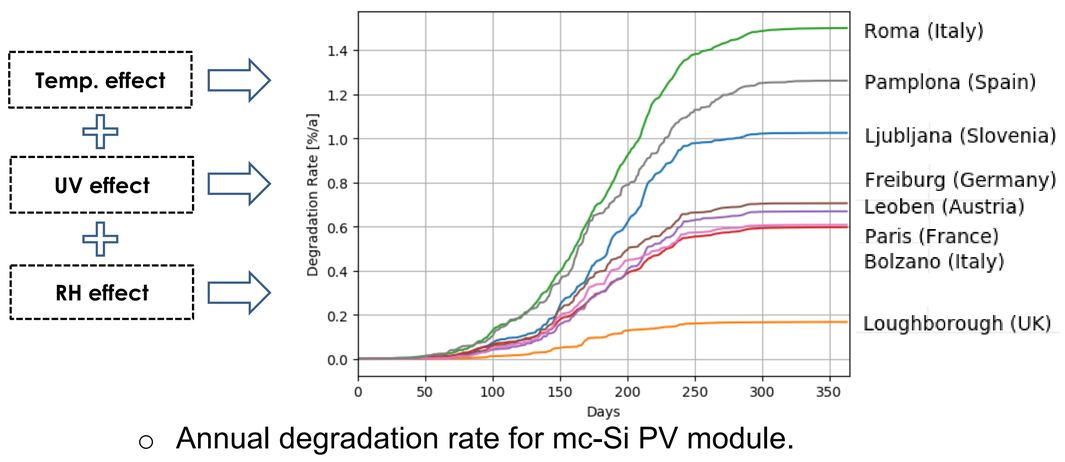
- From global gridded data we obtain the main variables of local climate to calculate the performance and degradation of PV modules and PV systems.

- If not measurements are available, we model the incident irradiance, cell operating temperature and relative humidity at the surface of the PV modules.

- Stress factors are calculated and used to quantify the impact of degradation modes, such as, corrosion, PID or combinatory stresses.



○ Flowchart to evaluate the degradation of performance from climate variables.



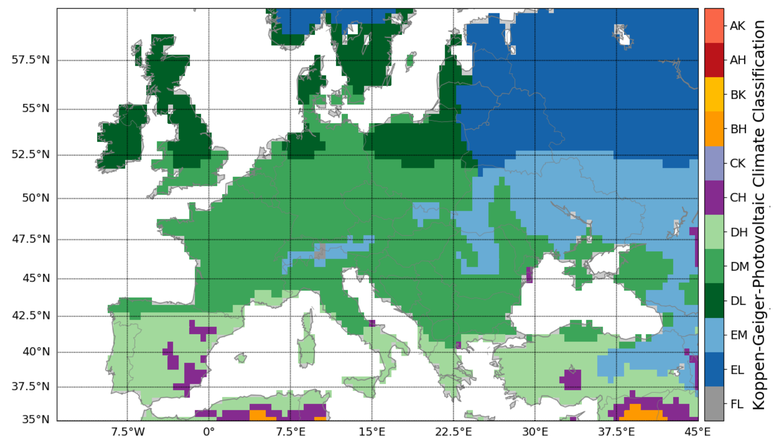
○ Annual degradation rate for mc-Si PV module.

CLIMATE CLASSIFICATION FOR PV SYSTEMS

- We divided the Earth in 12 Köppen-Geiger-Photovoltaic (KGPV) climate zones, which are named by one letter of the following groups:
  - Temperature-Precipitation (*TP*) zones
    A: Tropical B: Desert
    C: Steppe D: Temperate
    E: Cold F: Polar
  - Irradiation (*H*) zones
    K: Very High H: High
    M: Medium L: Low

Reduction of climate zones.

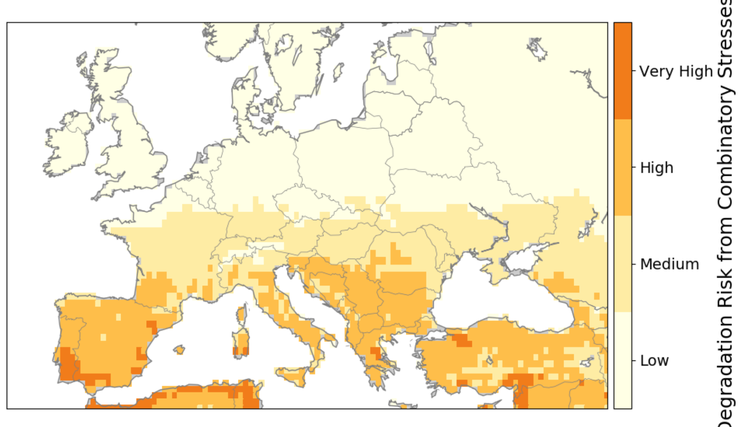
KGPV Zones	H zones L	M	H	K
T-P Zones A			X	X
B			X	X
C			X	X
D	X	X	X	
E	X	X		
F	X			



○ Koppen-Geiger-Photovoltaic climate classification in Europe.

PV DEGRADATION AND RISK MAPPING

- From the PV degradation mapping, we create 4 new categories to indicate the risk (Low, Medium, High or Very High) of a specific indicator (corrosion, PID, combinatory stresses, etc.)



Risk	Threshold Criteria
Low	$R_d < 0.5\%$
Medium	$0.5\% < R_d < 1.0\%$
High	$1.0\% < R_d < 2.0\%$
Very High	$2.0\% < R_d$

○ Risk map for degradation of mc-Si PV modules based on combinatory stresses.

○ European map for degradation of mc-Si based on Temperature, UV irradiation and Rel. Humidity effects.

CONCLUSION AND FURTHER WORK

- Combination of data sources (ground-,satellite-, reanalysis-based) can help the evaluation of performance and degradation of PV systems.

- Climate classification will be extended including new variables, such as, UV irradiation and temperature cycling.

- Development of degradation models from raw data and experimental data is on-going.

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