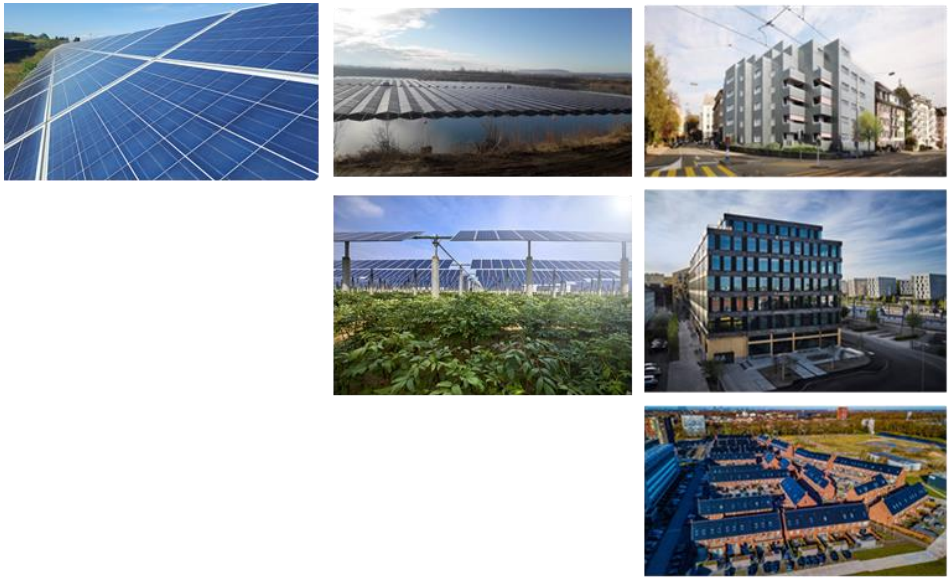


IEA PVPS

Adapting Solar PV Solutions for Climate and Applications

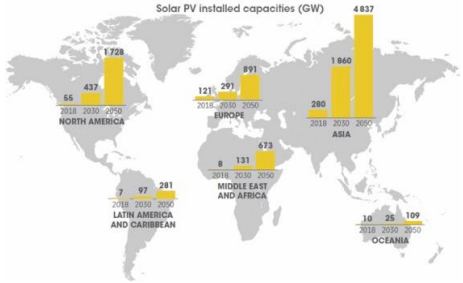
Workshop introduction

Gabi Friesen, SUPSI (CH) / Leonardo Micheli, UniRoma1 (IT)

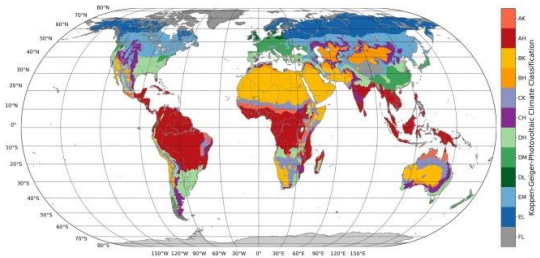
IEA PVPS Task 13 Workshop/Webinar at NREL, Colorado, USA, 17 October 2024

Workshop introduction

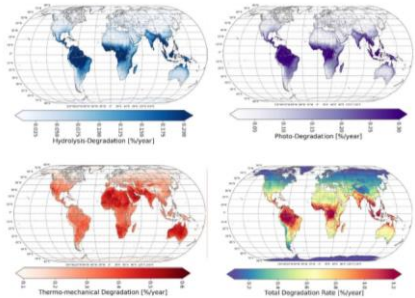
PV in different Climates



The world solar PV installed capacity by 2050 (IRENA, 2019).



Köppen-Geiger-Photovoltaic climate classification with the 12 most relevant climate zones (Julián Ascencio-Vásquez).
https://doi.org/10.1016/j.solener.2019.08.072



Global mapping of degradation mechanisms. a) Hydrolysis-degradation, b) photo- degradation, c) thermomechanical degradation, and d) Total degradation rates for a specific monocrystalline silicon PV module using the Kaaya model.

Challenges

- Climate specific design

  e.g. desert or alpine modules
- Testing for harsh environments

  e.g. sand, snow, wind, ice
- Field data availability

  e.g. alpine environment, climate specific degradation rates
- Climate Change

  increase of catastrophic events

PVPS

Workshop introduction

PV in different Applications

Challenges

- Diversification of products

  e.g. colored, curved, light-weight, semi-transparent, …

- Multifunctionality

  e.g. insulating, noise absorption, water tightness

- Complexity of system design

  e.g. mounting structures, integration, replaceable

- Adaptation of testing standards

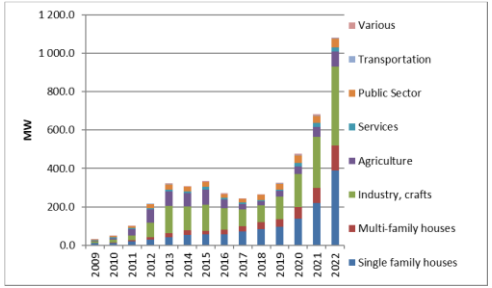
  e.g. safety requirements

- Lack of field data

  field stressor data, degradation rates

Example Switzerland

PV Applications
BAPV/BIPV



Task 1 – National Survey Report of PV Power Applications in Switzerland 2022

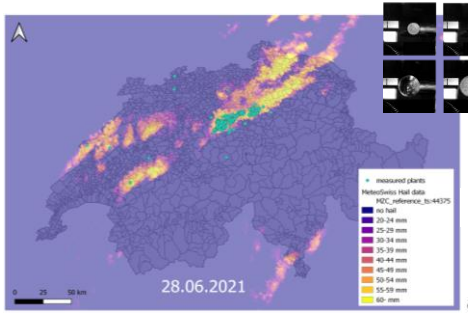
Prix solaire Suisse 2022 – www.solaragentur.ch

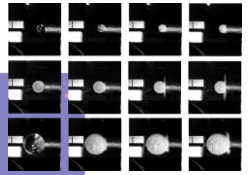
PV in different Climates
Alpine PV

Map with >50 PV systems https://alpine-pv.ch/

Sedrun Solar (2029 m.a.s.l.), 19.3 MW system under construction

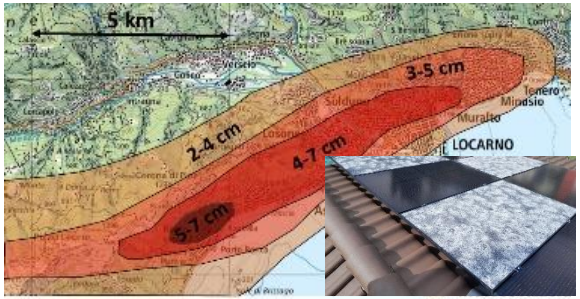
Climate change
Hail storms





University of Applied Sciences and Arts of Southern Switzerland
SUPSI
SPF INSTITUT FÜR SOLARTECHNIK
VKF AEAI
SWISSOLAR

Big Hail Storms in June and July 2021 (Achilles project)



Locarno (CH) hailstorm august 2023 (Cassandra project)

PVPS

IEA PVPS Task 13 Technical Reports

ST1.1 Degradation modes in new PV cell and module technologies

Report under preparation

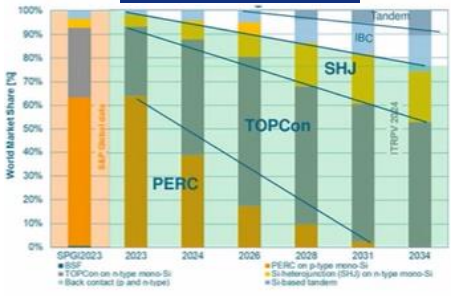
CONTENT

- ❑ New module concepts with cut-cells and new inter connection technologies
- ❑ New encapsulant and back-sheets
- ❑ Thinner glass
- ❑ TOPCon and SHJ technologies

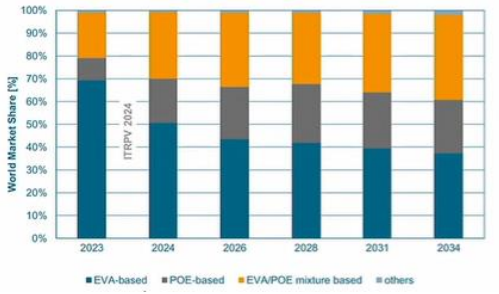
- Technological changes entered the market very fast without sufficient field data
- Optimization for efficiency and costs → Reliability?
- Numerous new degradation modes are reported from the laboratory and/or the field

  TOPCon UV degradation and contact corrosion, SHJ moisture induced degradation, thin glass breakage, back sheet cracking, new PID degradation modes, …

PV market share



Multi-layer encapsulants



➢ *Degradation patterns and phenomena of backsheets from diverse climate zones Laura Bruckman, CWRU, USA*

IEA PVPS Task 13 Technical Reports

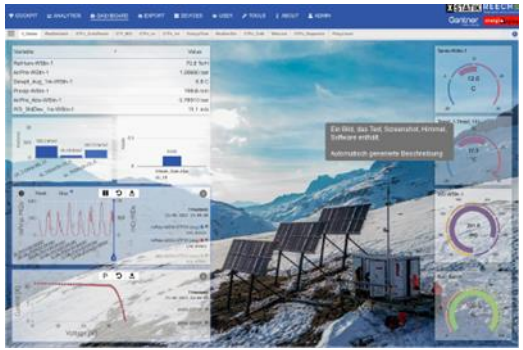
ST1.3 Accelerated testing methods incl. climate and application specific loads

Report under preparation

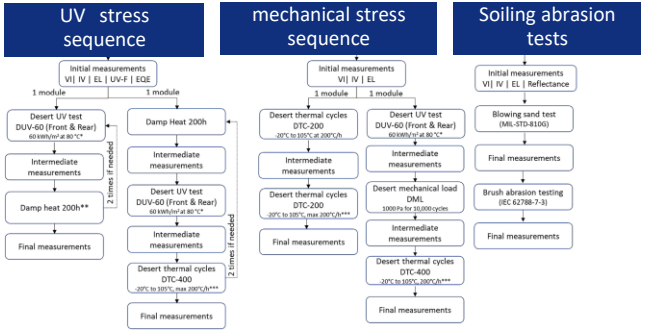
CONTENT

- ❑ New testing strategies
  - ▪ Sequential/combined/HALT
- ❑ Application specific testing
  - ▪ Floating and Agri PV
  - ▪ Vehicle and Building IPV
  - ▪ Alpine/Desert
- ❑ Component specific testing
  - ▪ Polymerics, connectors/cables, BOS

- Knowledge of stress factors (limited field data availability for some applications e.g. floating, alpine)
- Adaptation of type approval and safety standards for specific loads (multifunctionality and higher safety requirements increase complexity and costs e.g. BIPV, VIPV)
- Correlation of accelerated tests with field performance



Example of site monitoring for site evaluation
Source: Gantner - PV alpine 8 MW Sedrun Solat project in CH (2100 m)

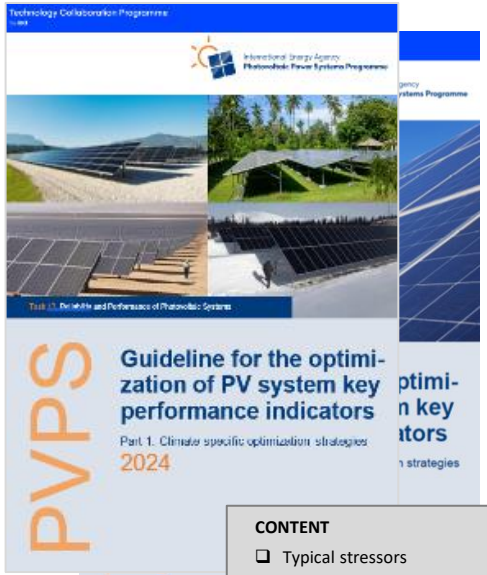


The conceptual flow chart for the proposed hot desert test cycle (HDTC) sequences. B. Adothu, DOI: 10.1002/pip.3827

➢ *Combined stress testing simulating different climatic conditions Peter Hacke, NREL, USA*

IEA PVPS Task 13 Technical Reports

ST3.2 Climate and Application specific optimization

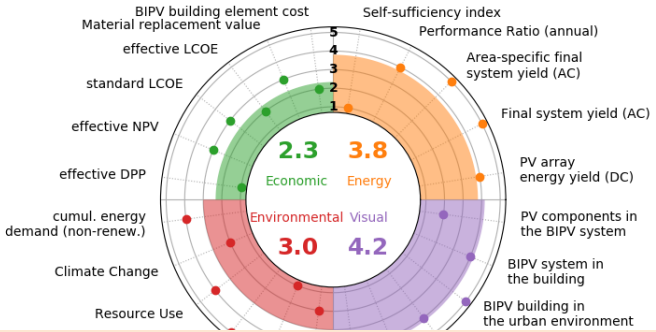


Report under preparation

CONTENT

- ❑ Typical stressors
- ❑ Best practice and mitigation strategies

- Load specific module and system design strategies (lifetime energy yield and costs)
- Impact of system design on O&M costs
- Multidimensional performance rating
- Importance of site assessments (data)



ration in the alpine

- ➢ *Adapting Module design and BOM for harsh climates Gernot Oreski, PCCL, Austria*
- ➢ *Anti-soiling coatings of PV modules for different climates, David Miller, NREL, USA*
- ➢ *Adapting Glass for various PV applications Michael Pilliod, centraltension, USA*
- ➢ *Experience with a high-altitude floating solar power plant, Andy Kaufmann, Romande Energie, Switzerland*

Conclusion

Technology trends towards higher efficiencies and lower costs are drivers for:

- integration of PV in new environments (from BIPV to IPV, FPV, APV, VIPV,…)
- numerous innovation of module design (colored, light weight, curved,…)

But!

- module environments are getting more challenging and testing more complex
- field experience is partially lacking behind leading to an increased number of failures


Image: Helioplant)

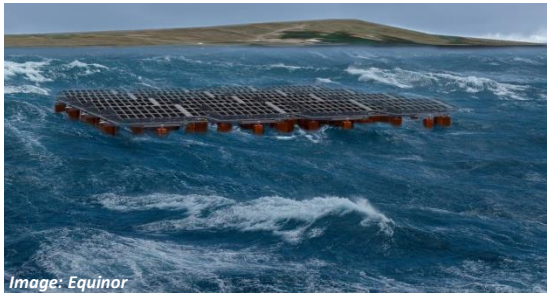


Image: Equinor


Image: Risk&Insurance

Thank you for your attention

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