Integrated Photovoltaic Conference

25 – 26 November 2025
Chamber of Commerce
Florence, Italy

MEZeroE
Measuring Envelope systems for Zero Energy buildings

tecnalia
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

Joseba Ormaetxea

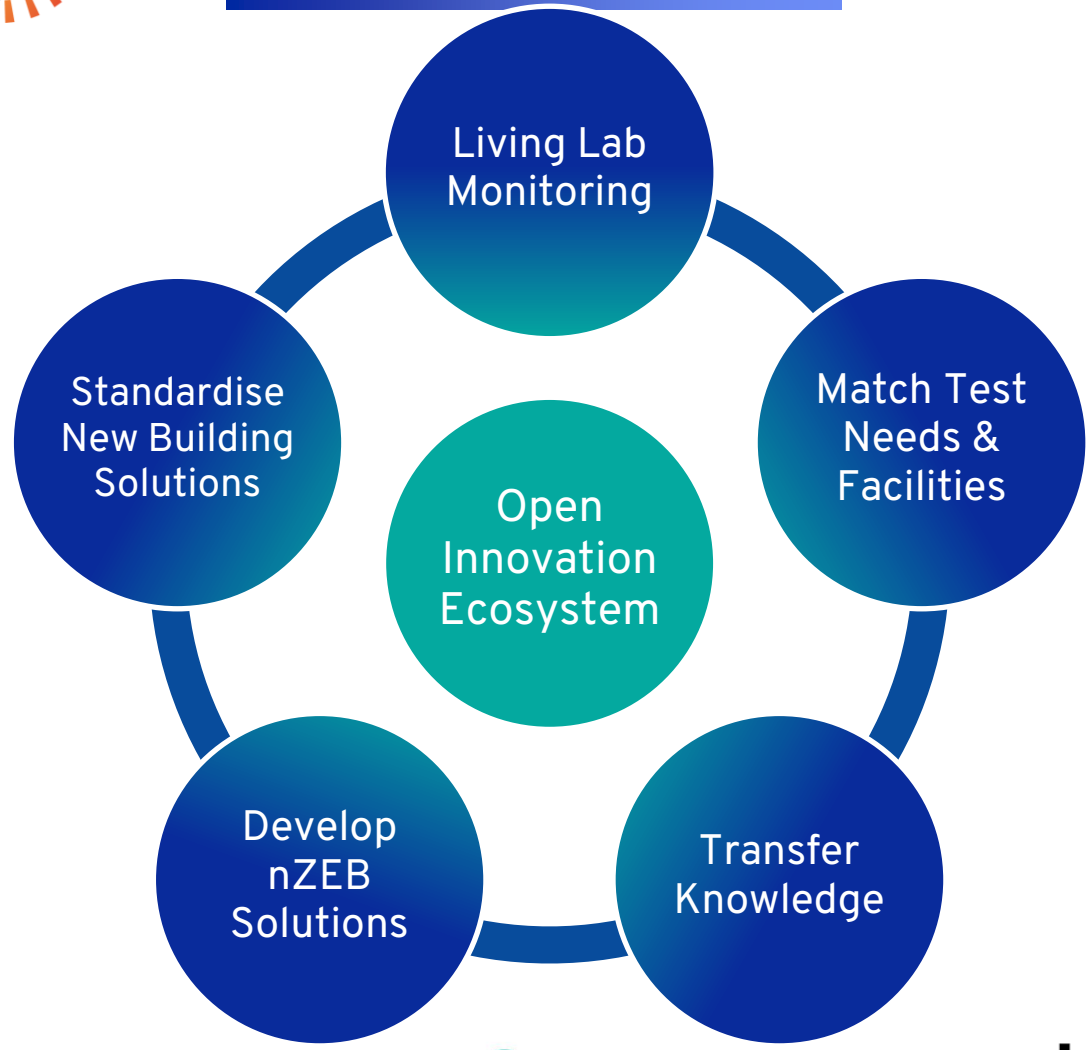
Tecnalia

Development and Application of New Extended-stress Sequences to Characterise Durability of BIPV Modules

Organised by
etaflorence renewableenergies

Content

Context – MEZeroE Project



New Single-Entry Point Virtual Marketplace:

- 9 Pilot Measurement & Verification Lines
- 3 Open Innovation Services

Pilot Measurement and Verification Line #1

Building-integrated environments

Aim:
Building Integrated products

- **Photovoltaic**
- **Solar Thermal**
- **Hybrid PV/T**

Testing:

- **Dynamic Wind Test**
- **Great Scale Calorimetric Hood**
- **Coupled Fire-Electric Test**
- **Optical Evaluation for Varying Incident Angle**
- **New Extended-Stress Test Sequences**
- **Performance Characterization in "Real" Conditions**

Efficiency

Safety

New Extended-Stress Sequences

Goal: ageing sequence for BIPV modules that guarantees durability

IEC 61215 ageing sequence is not intended to demonstrate long-term performance in all locations

IEC 63092 adds requirements for BIPV modules

IEC TS 63209 proposes a long-term performance testing sequence, but for conventional PV modules

Need for extended stress sequences for BIPV products

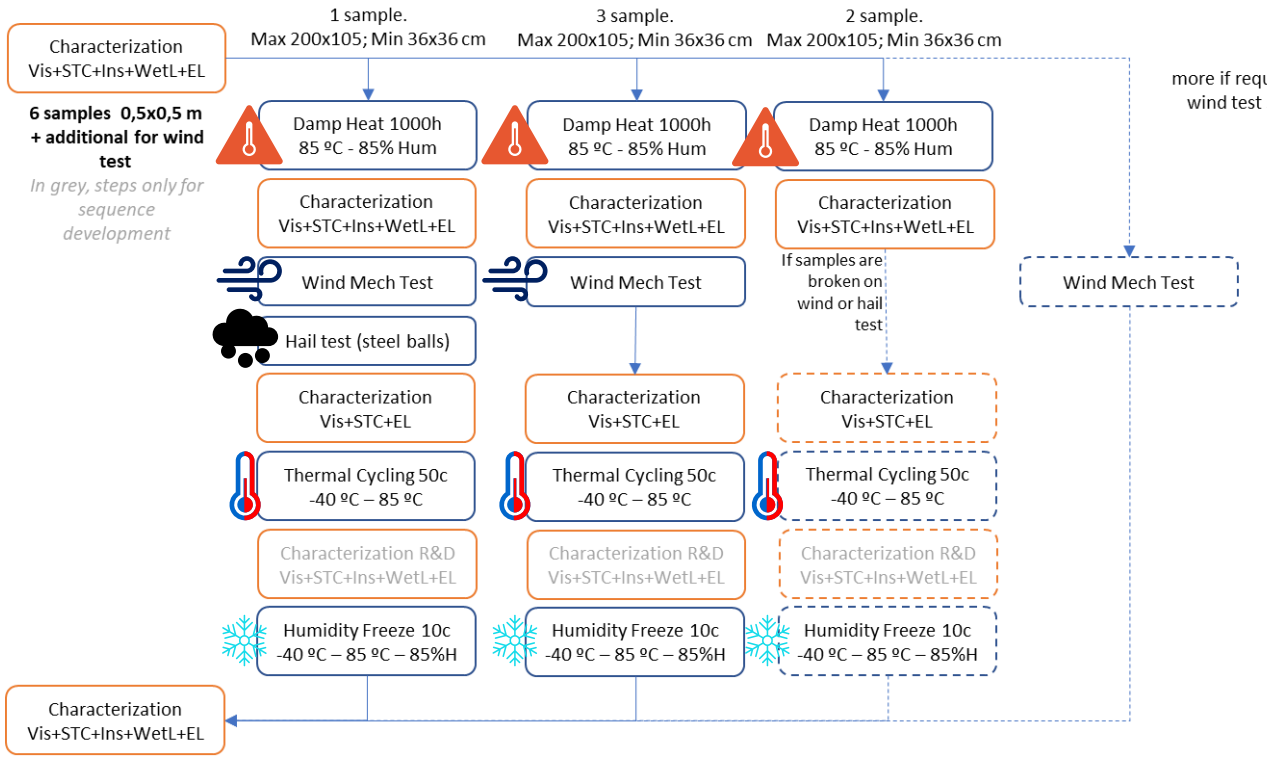
Long-term performance testing sequences for BIPV products:

1. Mechanical stresses & environmental ageing actions sequence
2. Thermal fatigue sequence
3. Combined UV and thermal fatigue sequence

Based on:
IEC 61215
IEC 63092
IEC TS 63209
ISO 12543-4

New Extended-Stress Sequences

Mechanical stresses & environmental ageing actions sequence



Based on:

- **IEC 63092**
- **Sequences C and E of IEC 61215**
- **Sequence 2 of IEC TS 63209-1**

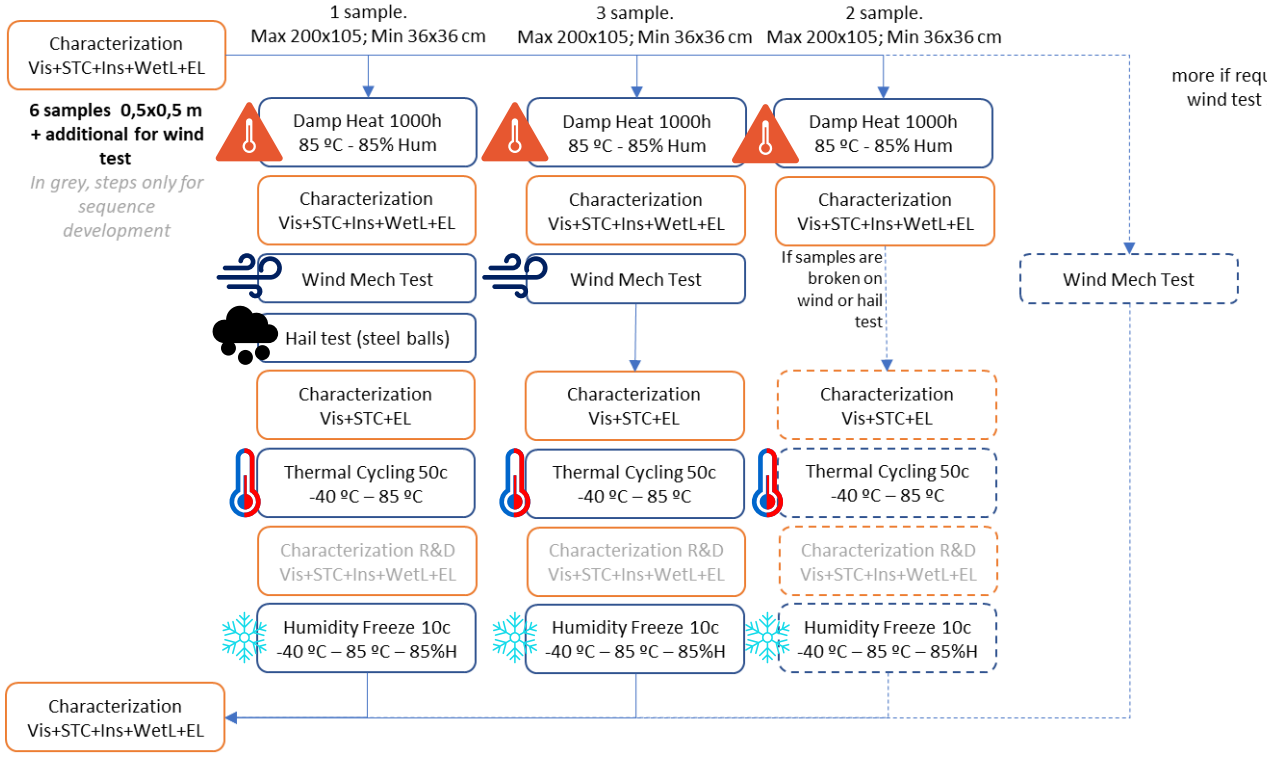
Intermediate characterizations:

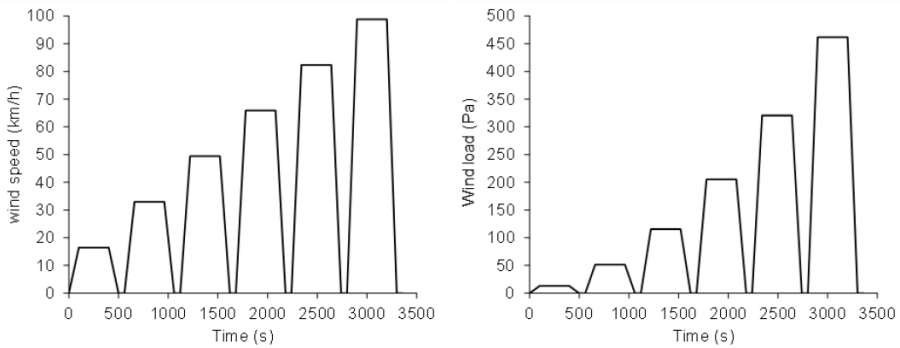
- Visual inspection
- IV curves
- Insulation testing
- Wet leakage
- EL imaging

Duration: ~2 months

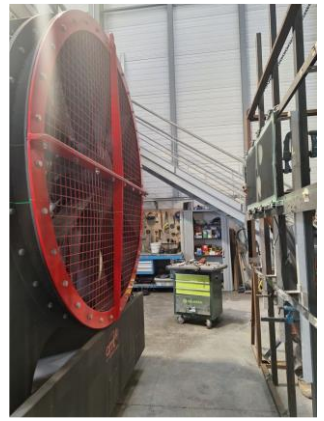
New Extended-Stress Sequences

Mechanical stresses & environmental ageing actions sequence



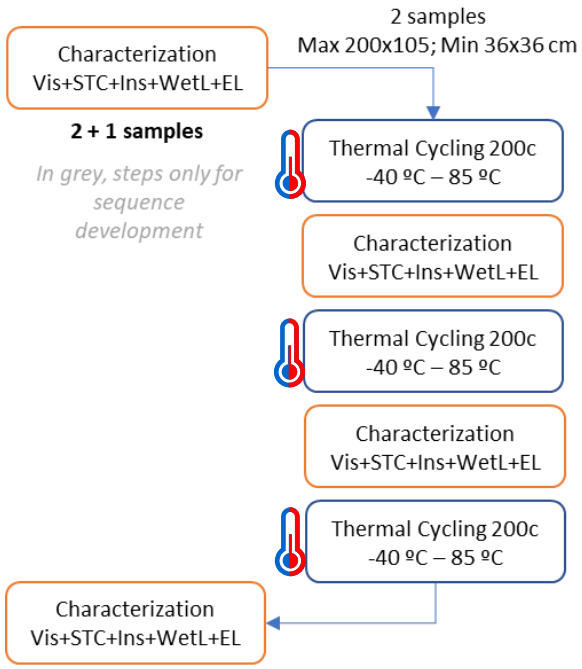


Dynamic wind load test set-up



New Extended-Stress Sequences

Thermal fatigue sequence



Based on:

- **Sequence 1 of IEC TS 63209-1**

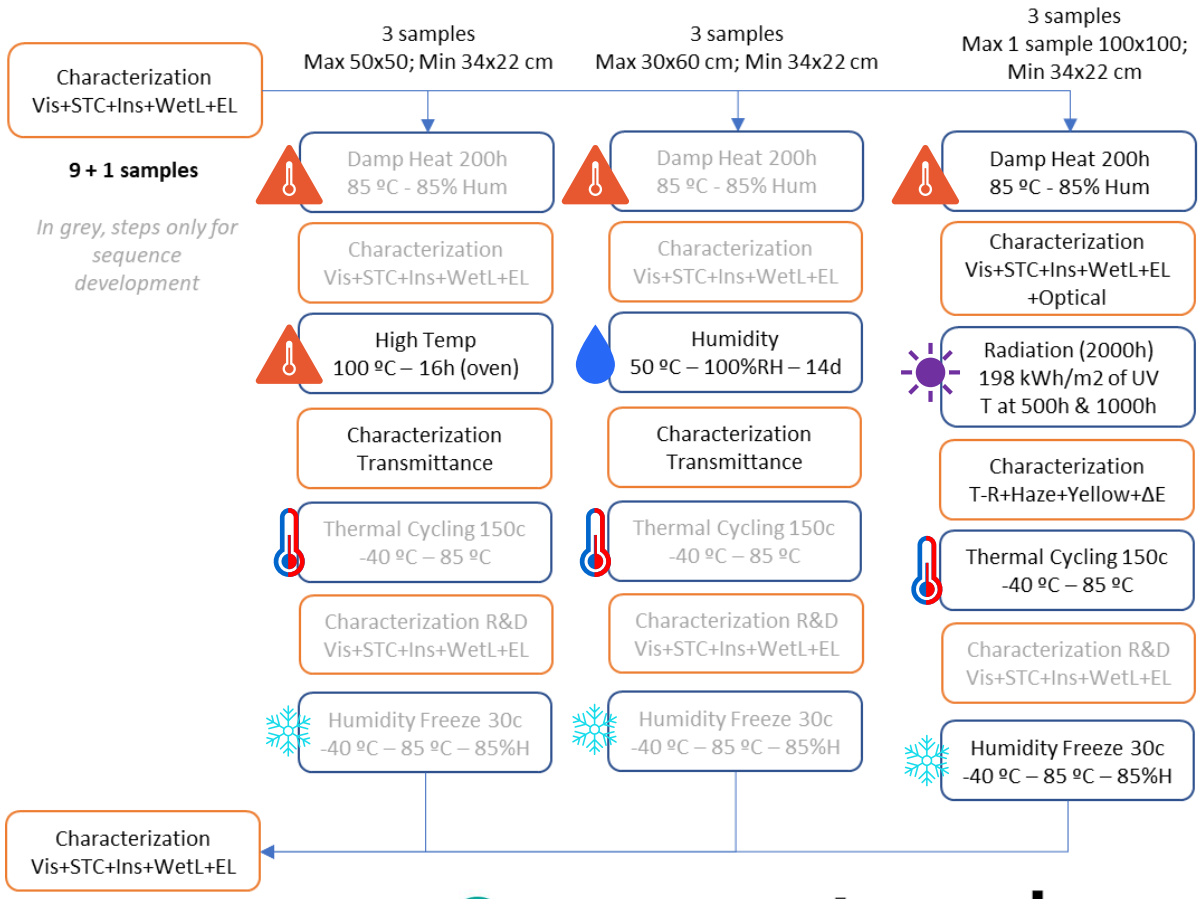
With intermediate characterizations:

- Visual inspection
- IV curves
- Insulation testing
- Wet leakage
- EL imaging

Duration: ~2.5 months

New Extended-Stress Sequences

Combined UV & thermal fatigue sequence



Based on:

- **Sequence 3 of IEC TS 63209-1**
- **ISO 12543-4 UV test**

With intermediate characterizations:

- Visual inspection
- IV curves
- Insulation testing
- Wet leakage
- EL imaging

Duration: ~4.5 months

Application – Results

3 innovative BIPV products + Glass module

	Flexbrick BIPV Module	3rd gen BIPV Module	Composite PV Module	Glass PV Module
Mechanical Stresses and Ageing Actions sequence	☒	☒	☐	☒
Thermal Fatigue sequence	☐	☒	☒	☒
Combined UV and Thermal Fatigue sequence	☐	☒	☒	☒
6-month outdoor exposure	☒	☐	☒	☒

Flexbrick BIPV Module

Confidential

3rd gen BIPV Module

Composite PV Module

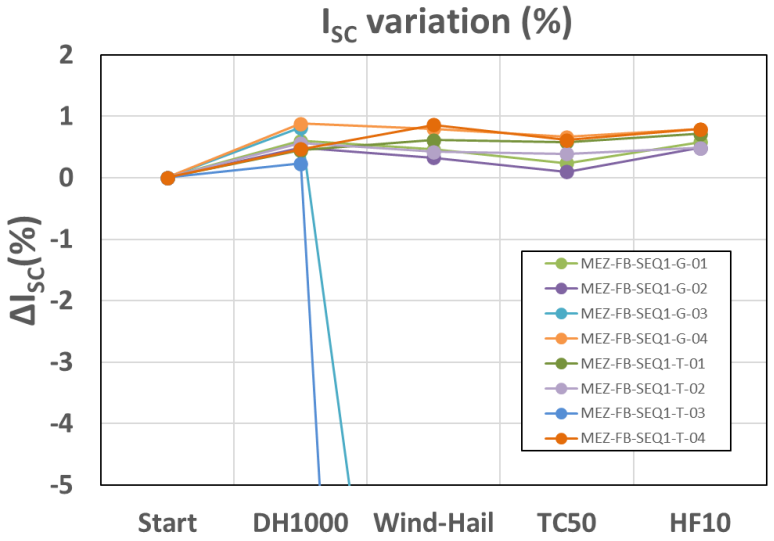
Glass PV Module

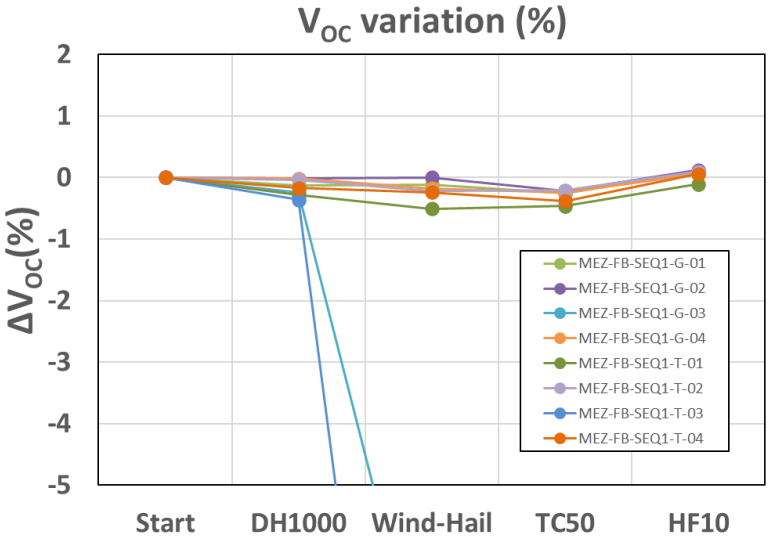
Application – Results

Flexbrick BIPV Module

Flexbrick BIPV Module

Mechanical stresses & environmental actions





Key results:

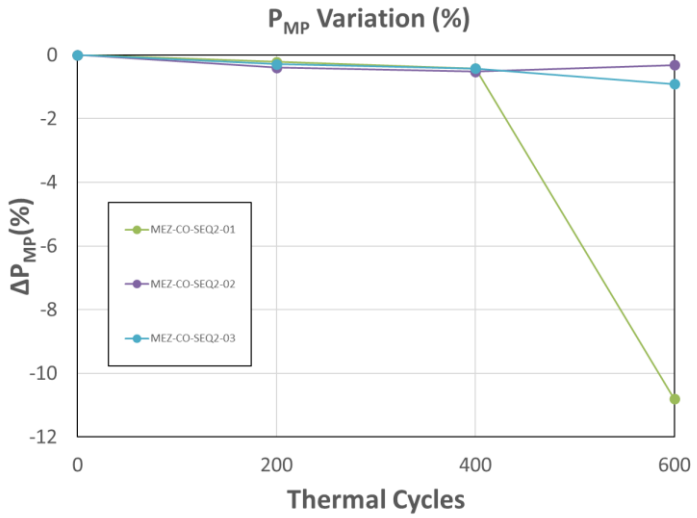
- The samples withstood all the tests performed.
- The product withstands 2J hail impacts, but 7J hail impacts cause fractures.
- A very small cumulative Isc and Voc variation was measured (<1%).

Application – Results

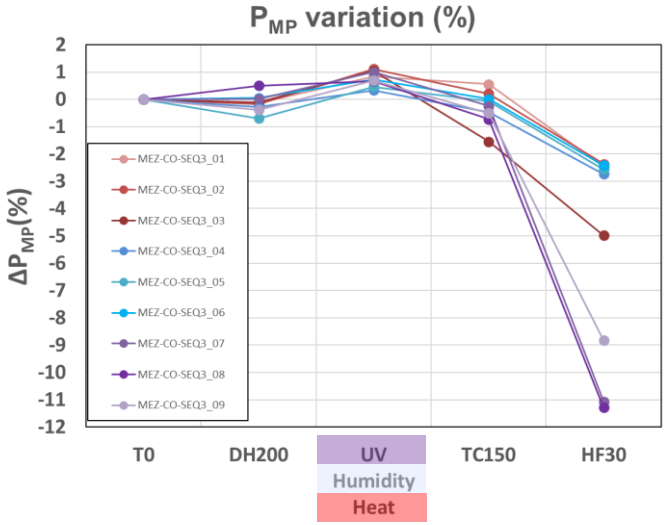
Composite PV Module

Composite PV Module

Thermal fatigue



Combined UV & thermal fatigue



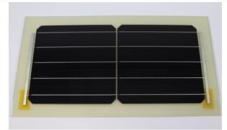
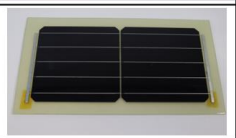
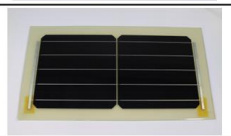
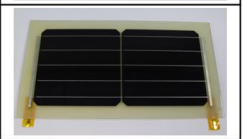
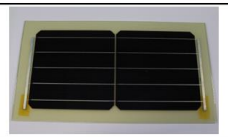
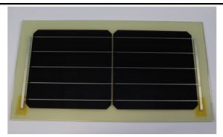
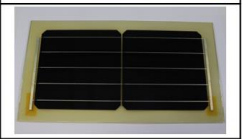
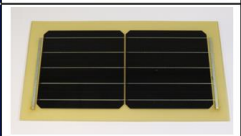
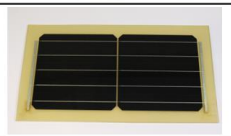
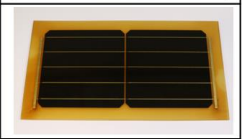
Key results:

- Thermal fatigue sequence withstood *(outlayer due to contact degradation).*
- Combined UV and thermal fatigue sequence: combination of UV exposition and humidity-freeze tests caused strong discoloration and performance loss.

Application – Results

Composite PV Module

Composite PV Module

	SEQ3_01 (High temperature)	SEQ3_04 (Humidity)	SEQ3_07 (UV radiation)
T0			
DH200			
HT / RH / UV			
TC150			
HF29			

Key results:

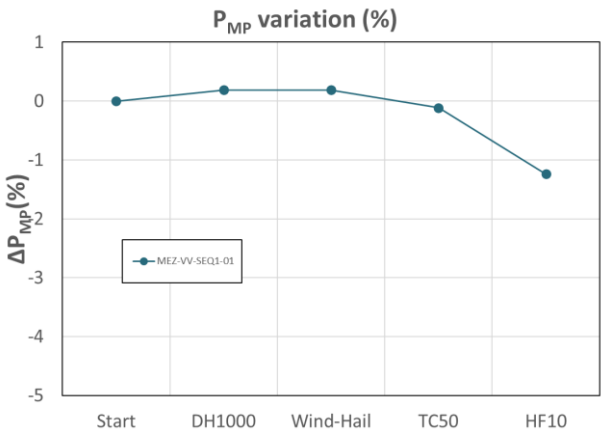
- Thermal fatigue sequence withstood.
- Combined UV and thermal fatigue sequence: combination of UV exposition and humidity-freeze tests caused strong discoloration and performance loss.

Application – Results

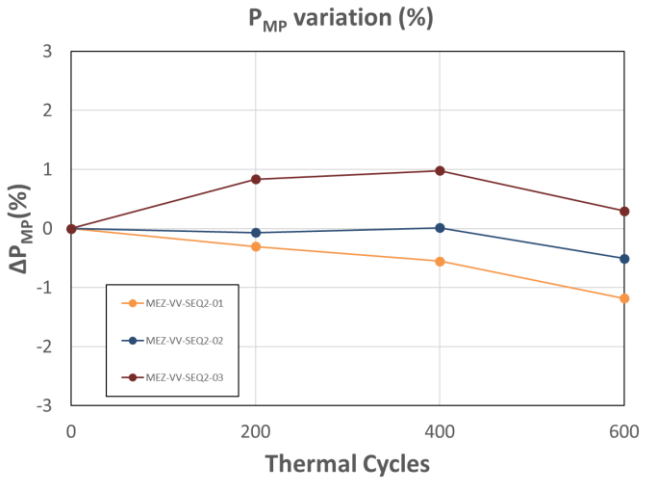
Glass PV Module

Glass PV Module

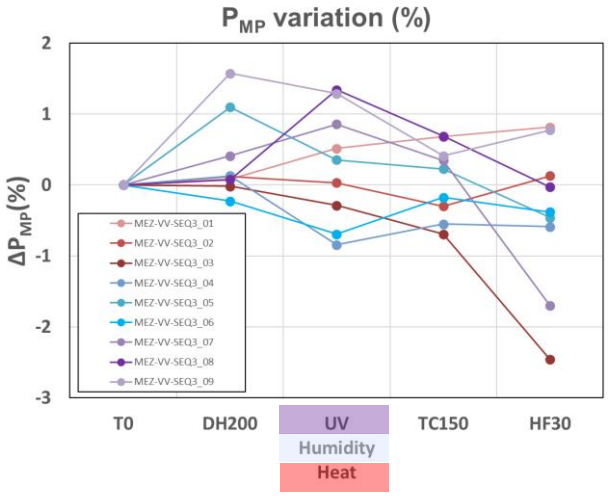
Mechanical stresses & environmental actions



Thermal fatigue



Combined UV & thermal fatigue



Key results:

- The samples withstood all the tests performed.

Concluding remarks

- **3 new extended stress sequences: enable testing for long-term reliability of BIPV modules.**
- The sequences may seem harsh, but a significant part of the modules resisted.
- The thermal fatigue sequence resulted to be relatively mild.
- In combined UV and thermal fatigue sequence, UV exposure (*laminated glass standard ISO 12543-4*) resulted to be severe.
- All tested samples withstood the new dynamic wind load test, and the mechanical and environmental ageing sequence as well.
- Combined effects of tests observed in sample degradation: intermediate characterization important.
- The sequences provide information on reliability and design improvement capabilities of BIPV products.

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Thank you!

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